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VOL. CXLI.—No. 3660] LONDON: FRIDAY EVENING, FEBRUARY 19, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 4th March, 1926, for EXTENDING the LOW-PRESSURE HOT WATER HEATING SYSTEM at Wakefield Post Office and Telephone Exchange.

Drawings, specifications, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sum so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1619

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

CARRIAGE UNDERFRAMES and FITTINGS.

Tenders due on the 16th March, 1926.
Tender forms obtainable from above. 1662

G.I.P. RLY. ELECTRIFICATION.

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

THE COMPLETE EQUIPMENT FOR ONE ROTARY CONVERTER SUB-STATION, and

THREE SEPARATE ROTARY CONVERTER SETS and TRACK SECTIONING SWITCHGEAR.

Tenders due on the 30th March, 1926, before 2 p.m. Specification and form of Tender obtainable from the above at a fee of £2 for the first three copies and £1 for each further copy. 1683

Candidature is Invited from well-qualified Mechanical Engineers with specialised experience in Rate-fixing, who have served in H.M. Forces, for the following pensionable APPOINTMENTS in the Technical Costs Section of the Contract and Purchase Department of the Admiralty:—

1 PRINCIPAL TECHNICAL COSTS OFFICER (salary to be fixed).
3 TECHNICAL COSTS OFFICERS, £350-15-500 (A).
3 ASSISTANT TECHNICAL COSTS OFFICERS, £250-15-357.
(A) 1 with an allowance of £50 p.a., as Deputy Head of the Section.

The above posts carry Civil Service bonus, amounting at present rates to approximately £119 on a salary of £250, £145 on £350, £152 on £375, and £184 on £500.

Candidates must have attained the age of 25 years and not have attained the age of 50 years by the 27th February, 1926, which is also the latest date by which applications will be accepted.

Copies of the regulations governing the above appointments, and forms of application, may be obtained from the SECRETARY (C.E.), Admiralty, Whitehall, S.W. 1. 1644

Civil Engineer Required by the GOVERNMENT of the BAHAMAS for four years' service, with possible extension. Salary, £450 a year. Free first-class passages. Candidates must be unmarried, 25-35 years of age, must have had good professional training as Civil Engineers and have subsequently had several years' experience on large engineering works, such as are undertaken by municipalities in particular road and building construction, surveys and preparation of plans and estimates, &c.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/12,676. 1650

Civil Engineers (3) Required by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT for two tours of from 12 to 18 months' service, with possible extension. Salary £600, rising to £720 a year by annual increments of £30. Outfit allowance of £60 on first appointment. Free passages and quarters and liberal leave on full salary. Candidates, aged 30 to 35, must have served articled with a corporate member of the Institution of Civil Engineers and have passed the examination qualifying for A.M.I.C.E. or hold equivalent professional qualifications. Must be good draughtsman, capable of designing and carrying out buildings, bridges and other engineering structures and of taking out quantities and preparing detailed plans and estimates. Must be competent to execute surveys and to lay out and construct roads and have had experience as civil engineers on the construction of roads, buildings, and other public works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14,274. 1652

Quantity Surveyor Required for the PUBLIC WORKS DEPARTMENT of SIERRA LEONE for two tours of 12 to 18 months' service, with possible extension. Salary £540, rising to £720 a year by annual increments of £30. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 28 to 35, must be fully qualified Quantity Surveyors, experienced in the practice of "taking off," "billing," and "estimating" and "measuring up" for all classes of building work. Should have been engaged in a first-class quantity surveyor's office, and preference will be given to candidate holding the Fellowship of the Surveyors' Institution in the Quantities Division.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/14,277. 1651

B.B. & C.I. Railway Company. The Directors are prepared to receive up to Noon on Friday, 5th March, TENDERS for the SUPPLY of—

STEEL MATERIAL for CONSTRUCTING CARRIAGES and WAGONS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each, which will not be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices:
The White Mansion,
91, Petty France, S.W. 1.
17th February, 1926. 1670

The Engineer

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PUBLIC NOTICES

Administrative County of LONDON.

SALE OF FIREFLOAT "BETA II."

The London County Council invites OFFERS for the PURCHASE of the TWIN-SCREW STEEL FIREFLOAT "BETA II.," of which particulars are given hereunder:—

Built by Forrest and Co., of Wyvenhoe, in 1906.
Registered tonnage about 22.
Dimensions, 100ft. by 16ft. 6in. by 3ft. 9in.
Speed about 9 knots.
Triple-expansion engines, 150 I.H.P. each, by Mumford's, of Colchester.
Two Mumford's W.T. boilers with forced draught and oil fuel.
Three fire pumps, by Shand-Mason, of London, capacity of each about 1000 g.p.m. at 120 lb. pressure.

Further particulars can be obtained from the Chief Officer of the London Fire Brigade, 94, Southwark Bridge-road, S.E. 1.

The Council does not bind itself to accept the highest or any Offer.

MONTAGU H. COX,
1618 Clerk of the London County Council.

County Borough of Grimsby. TO BRIDGE BUILDERS.

The Corporation of Grimsby invite TENDERS for the CONSTRUCTION of a LIFTING BRIDGE over the Alexandra Dock at Grimsby, about 45ft. span and 50ft. in width, together with 240 LINEAL FEET of VIADUCT, 50ft. in width.

Forms of Tender, specifications, bills of quantities and blue prints of certain of the drawings may be obtained on and after the 17th instant at the office of the Borough Engineer, Mr. H. Gilbert Whyatt, M. Inst. C.E., 170, Victoria-street, Grimsby, on payment of a deposit of £10 10s., which will be refunded on receipt of a bona fide Tender or on the return of the papers within one week of their receipt by the contractor.

The Corporation do not bind themselves to accept the lowest or any of the Tenders, and no payment will be made to any contractor for any expenses incurred by him in the preparation of his Tender.

Tenders, endorsed "Bridge over Alexandra Dock," and addressed to the "Chairman of the Bridge Committee," must be delivered at my office not later than Noon on Monday, March 15th.

JOHN W. JACKSON,
Town Clerk.

Municipal Buildings,
170, Victoria-street, Grimsby.
10th February, 1926. 1608

THE PROPRIETORS of an ENGINEERING JOURNAL are DESIROUS of FORMING a TECHNICAL COMMITTEE of qualified Engineers to act in an advisory capacity. APPLICATIONS are INVITED from GENTLEMEN who are corporate members of the Institutions of Civil, Mech., or Elec. Engineers or who hold a recognised Degree or Diploma.—Address, 1632, The Engineer Office.
1632

PUBLIC NOTICES

City of Birmingham Water DEPARTMENT.

The Water Committee of the Corporation of the City of Birmingham is prepared to receive TENDERS from competent firms for the MANUFACTURE and DELIVERY of SLUICE VALVES and IRONWORK in connection with their Bartley Reservoir now under construction.

Drawings may be inspected at the office of the Chief Engineer of the Water Department, Council House, Edmund-street, Birmingham, between the hours of 10 a.m. and 4 p.m. (10 a.m. and 12 noon, Saturdays).

Specifications and forms of Tender may be obtained from the Secretary of the Water Department, Council House, Birmingham, on payment of the sum of £1 1s., which amount will be refunded on receipt of a bona fide Tender.

Sealed Tenders, on the form provided for the purpose, addressed to "The Secretary, Water Department, Council House, Birmingham," and endorsed "Sluice Valves, &c., Contract 10," should be delivered at the Secretary's Office on or before 10 a.m. on Friday, 26th February, 1926.

The Water Committee does not bind itself to accept the lowest or any Tender.

F. W. MACAULAY, M. Inst. C.E.,
Chief Engineer.
J. H. BROADLEY,
Secretary.

Water Department,
Council House, Birmingham,
8th February, 1926. 1566

City of Liverpool. WATER ENGINEER'S DEPARTMENT.
CONTRACTS FOR THE SUPPLY OF MATERIALS, &c.

The Corporation are prepared to receive TENDERS covering the period of Twelve Months ending 31st March, 1927, in respect of the MATERIALS, &c., set out in the undermentioned Schedules, viz.:—

1. BRASS CASTINGS and FITTINGS.
2. CARTAGE.
3. LEAD PIPE.
4. CAST IRON PIPES.
5. MISCELLANEOUS IRON PIPES AND CASTINGS.
6. SLUICE VALVES.

Separate Tender forms, including specification and schedule, for any of the above items will be forwarded upon receipt of application in writing to the Water Engineer, Alexandra Buildings, 55, Dale-street, Liverpool.

Duplicate forms of Tender for record purposes will not be supplied.

Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions in the form of Tender, and forwarded through the post, addressed to "The Town Clerk, Municipal Buildings, Liverpool," so as to be delivered not later than Ten o'clock a.m. on Tuesday, the 2nd March, 1926.

WALTER MOON,
1655 Town Clerk.

PUBLIC NOTICES

Salford Union. OLD PEOPLE'S HOMES, STOTT-LANE, PENDLETON.
HEATING, HOT WATER SUPPLY AND VENTILATION.

The Guardians are prepared to receive TENDERS for complete HEATING, HOT WATER SUPPLY and VENTILATING INSTALLATIONS at the above Institution.

Plans and specifications obtainable on application to Mr. Charles Swain, Architect, 12, Exchange-street, Manchester, on payment of a deposit of Three Guineas, which will be returned on the receipt of a bona fide Tender.

Tenders, endorsed "Heating, Installation, &c., Old People's Homes," on face of envelope, must be received by the undersigned not later than 10 a.m. on Saturday, 6th March, 1926.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
E. H. INCHLEY,
Clerk to the Guardians.

Poor Law Offices,
Eccles New-road, Salford,
8th February, 1926. 1564

The South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

CARRIAGE UNDERFRAMES.

Specification and form of Tender will be available at the company's office, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Carriage Underframes," must be left with the undersigned not later than Twelve Noon on Friday, the 5th March, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

W. B. REYNOLDS,
for Managing Director.

91, Petty France,
Westminster, S.W. 1.
17th February, 1926. 1671

West Ham Union.

The Guardians are desirous of having carried out ALTERATIONS to the ELECTRIC LIGHTING STATION and the INSTALLATION of a STEAM-DRIVEN GENERATING SET, and certain other Work in connection therewith, at their Central Home, Leytonstone.

Firms able to carry out the work are invited to forward their names to the CLERK to the GUARDIANS, Board Room, Union-road, Leytonstone, E. 11.
1605

Commissioners for the Port of RANGOON.

There are VACANCIES in the COMMISSIONERS' ENGINEERING STAFF for TWO ASSISTANT CIVIL ENGINEERS. Applicants should be unmarried, British subjects, between the ages of 25 and 30, who have received a good general education, preferably at a public school; are Chartered Civil Engineers who have passed the Associate Membership Examination of the Institution of Civil Engineers, and had not less than two years' practical experience on Port or Harbour Work since completion of their indentures or equivalent training.

The engagement in the first instance will be for three years, but it is possible that at the end of that term the persons appointed would, if suitable, be placed on the permanent establishment should vacancies occur.

The salaries of the appointments are Rs. 750, rising by annual increments of Rs. 40 to Rs. 900 per mensem, with a motor cycle allowance of Rs. 50 per mensem; the increments are subject to passing the Government examination in Colloquial Hindustani, and conduct and work being reported as satisfactory. In the event of Port Commissioners' quarters being available, and occupied by an Assistant Engineer, rental of 7½ per cent. of salary will be payable.

The officers appointed will be provided with free first-class passages to Rangoon, and £10 each for expenses on the voyage. Should they, on the termination of their agreement, elect to return to England, they will be granted the same concession.

Applications, in writing, giving a full statement in chronological order, of education and experience, should be addressed, not later than the 1st day of March, 1926, to J. LUMSDEN RAE, Esq., Dartmouth House, 2, Queen Anne's-gate, Westminster, S.W. 1. 1600

The East Worcestershire Waterworks Co. require the SERVICES of a RESIDENT MANAGER and ENGINEER. Applicants for the post should be experienced in Diesel pumping plants, main laying, estimates, &c., and the control of men. Salary £350 a year, with house, light and fuel free. State age and qualifications, with copies of recent testimonials.—Applications to be sent by March 5th to F. E. WALKER, 18, Waterloo-street, Birmingham. P1591

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PUBLIC NOTICES

Walsall and West Bromwich
UNIONS JOINT COMMITTEE.

The Committee invite TENDERS for VERTICAL STEAM BOILER and LAUNDRY MACHINERY for their Laundry at Great Barr Park, in accordance with specification prepared by Messrs. Edwards and Shaw, of 105, Colmore-row, Birmingham.

Conditions of contract may be seen at my office and specification and form of Tender obtained from me between the 18th and 24th February.

Tenders may be sent in for the whole or for any one or more of the appliances required.

Tenders, endorsed "Laundry Machinery, Great Barr Park," to reach me not later than first post on Wednesday, the 3rd March, 1926.

By Order,
A. H. WARD,
Clerk.

22, Lombard-street, West Bromwich.
16th February, 1926. 1642

The Fire Salvage Association of Liverpool, Limited, is prepared to receive APPLICATIONS for the POSITION of SUPERINTENDENT at their Chief Station. Commencing salary £400 per annum, with house, &c., and good prospects of promotion.

Applicants must not be over 35 years of age and must possess engineering qualifications as well as experience in handling men.

Replies, stating age, height, qualifications and experience, to be addressed to the CHIEF OFFICER, Fire Salvage Association of Liverpool, Limited, 16, Hatton-garden, Liverpool.

Canvassing in any form will disqualify. 1648

SITUATIONS OPEN

WANTED, an ENGINEER Capable of Taking Charge of old-established Engineering and Ironfounders' Business in West of England, including Works Control, Estimating and Correspondence.—Address, with particulars, 1593, The Engineer Office. 1593 A

WANTED for Birmingham, ENGINEER REPRESENTATIVE. Knowledge of Pneumatic Tools and Plant essential.—Address age and full particulars of training, experience, salary required, together with references, 1575, The Engineer Office. 1575 A

WANTED, Fully Qualified CIVIL ENGINEER, preferably young, unmarried, as SECOND ASSISTANT on Construction Railways and Workshops in Portuguese Angola, S.W. Africa, high altitude, healthy climate. Previous experience railway construction in tropical countries, including surveys, &c., essential. Knowledge of Portuguese a recommendation. Free passage out and home, free quarters. Two years' agreement. Salary £50 per month.

Reply by letter only, stating age, &c., full particulars previous experience, and forward copies only testimonials, to SIR DOUGLAS FOX and PARTNERS, Broadway Buildings, Westminster, S.W. 1.

Endorse envelope "Application for 2nd Assistant Engineer." 1647 A

WANTED, Live BUSINESS MAN; Previous Experience Engineering Merchant's Office. Small commencing salary; good prospects if capable taking responsible position.—Address, 1631, The Engineer Office. 1631 A

WANTED, Thoroughly Qualified ENGINEER with experience in Furnace Design and preferably with some commercial experience. Manchester area. State full particulars of qualifications and salary expected.—Address, 1559, The Engineer Office. 1559 A

ASSISTANT ENGINEER REQUIRED, with Harbour Experience, for Marine and other Survey Work in East Africa. Salary, £500 per annum, with free quarters, half salary on voyages out and home.—Apply, stating age and giving full particulars of experience, to XYZ, c.o. Brown's, 39, Tothill-street, S.W. 1. 1668 A

ASSISTANT WORKS MANAGER REQUIRED for Large Plant manufacturing Lap-welded Tubes by water gas process. Must be good organiser and have thorough knowledge of the trade. State experience and salary.—Address, 1617, The Engineer Office. 1617 A

BELGIUM.—An Important BELGIAN WORKS, manufacturing engineers' small tools (Twist Drills, Reamers, Screw Taps and Dies, &c.), REQUIRE the SERVICES of an ENGINEER who can take full charge of this department. A good knowledge of the French language is desirable. Applications, with age, education, particulars of experience, copies of references, and salary required should be sent.—Address, P1572, The Engineer Office. P1572 A

ENGINEER, CIVIL (Contractor's Sub-Agent Preferred), with Mechanical and Electrical Experience, for work in this country. Age about 30.—Reply, stating experience fully, giving reference, to "Z.C. 394," c.o. Deacon's, Fenchurch-avenue, London. 1665 A

MECHANICAL ENGINEER REQUIRED, with practical knowledge of and experience in the design, construction and working of Cableways, Blondins, &c.—Address, stating age, experience, and salary required, 1611, The Engineer Office. 1611 A

REQUIRED by Old-established Firm in India, capable MACHINE TOOL SALESMAN, age 24 to 26, unmarried, with practical Machine Shop Experience and conversant with Railway Workshops Requirements.—Applications must state age, full particulars, experience and salary required, to Z.M. 348, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 1660 A

RESIDENT ENGINEER REQUIRED IMMEDIATELY, to Take Charge of Refrigerator Plant, Diesel Engine, Electrical Plant, and General Machinery, &c. &c., at the "Four Counties" Bacon Factory, Limited, Eastleigh, Hants.

Apply by letter, stating experience, wages required, and enclose copies of testimonials, to H. HANSEN, Manager. 1641 A

SALES ENGINEER WANTED for Power Transmission Belting. Replies solicited only from applicants capable of cultivating first-class connections and with knowledge of transmission problems.—Address fully, with record and qualifications, 1582, The Engineer Office. 1582 A

WORKS MANAGER WANTED for Manchester Firm of Constructional Engineers, output 200/300 tons per week. Must have held similar post and be capable and efficient organiser. Give full details, age, experience, salary, and when at liberty.—Address 1613, The Engineer Office. 1613 A

WANTED in a Railway Engineer's Office in Manchester, a competent STEEL WORK DRAUGHTSMAN. Must have had experience in Bridge Construction and be capable of measuring up and calculating the strength of iron and steel structures.—Address, 1606, The Engineer Office. 1606 A

WANTED, LEADING DRAUGHTSMAN, to Act as Deputy to Chief Draughtsman. Age about 35. Must have good practical and theoretical knowledge of Steam Engines, Boilers and Accessories for land purposes.—Address, stating full particulars of experience and salary required, 1645, The Engineer Office. 1645 A

CHIEF DRAUGHTSMAN REQUIRED, with Good experience in small high-class Marine Machinery and auxiliaries; good permanent position for suitable man, preferably one with experience of Ships' Auxiliaries for various duties. State age, particulars of past experience and salary expected.—Address, 1655, The Engineer Office. 1655 A

CHIEF DRAUGHTSMAN WANTED for West of England Structural Works, to Take Charge of Drawing-office of 5 senior draughtsmen and juniors. Must be a first-class man, well up in designing Light Structural Work for Factory Buildings, &c. Give full particulars as to experience, &c., salary required.—Address, 1624, The Engineer Office 1624 A

ARNOLD BOOKS

THE STRENGTH OF MATERIALS.
A Treatise on the Theory of Stress Calculations for Engineers.
By JOHN CASE, M.A., F.R.Ae.S.
Lecturer in Applied Mechanics at the Royal Naval Engineering College, Keyham.
With many diagrams. 8vo. **30s.** net.

The Times.—"The work as a whole is not merely one for the instruction of students but should also serve a useful purpose as a reference book for practical engineers."
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STRENGTH AND STRUCTURE OF STEEL AND OTHER METALS.
By W. E. DALBY, F.R.S., London University Professor of Engineering at the City and Guilds Engineering College of the Imperial College of Science and Technology.
With 169 Diagrams, including 38 plates from original microphotographs. 8vo. **18s.** net.

REINFORCED CONCRETE DESIGN.
Vol. I.—Theory. By OSCAR FABER, D.Sc., and P. G. BOWIE. **14s.** net.
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Vol. II. contains B.M. Diagrams for beams of any span, any ratios of live to dead load, and any fixity with monolithic columns of different relative stiffness.

MODERN ROADS.
By H. PERCY BOULNOIS, M. Inst. C.E., Chairman of the Council of the Roads Improvement Association, etc. With Illustrations. **16s.** net.

The Surveyor.—"The information given is not only up-to-date and reliable, but all the modern methods of road-making are fully described and critically discussed in a way that only an engineer of the experience and standing of the author could be expected to do."

LONDON EDWARD ARNOLD & CO. 41 & 43, MADDOX ST. W.

SITUATIONS OPEN (continued)

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 1169 A

DETAILERS for Structural Works Office WANTED. None but draughtsmen trained in Structural Works need apply. State salary, experience.—Address, 1625, The Engineer Office. 1625 A

DRAUGHTSMEN REQUIRED, Engineering Works in South-West of England, with knowledge of Elevating and Conveying Machinery, combined with Steel Structural Work. State age and experience.—Address, 1612, The Engineer Office. 1612 A

DRAUGHTSMAN, First-class, WANTED, with up-to-date experience in the Lay-out and Design of Material-handling Plants.—Write, stating full particulars of experience, age and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 1669 A

DRAUGHTSMAN (SENIOR) WANTED for Constructional Steel Work. Well accustomed to the full routine of a Constructional Engineer's Estimating and Order Office. Well up in calculations and stresses. Say when disengaged, wages required, age, and fullest particulars.—Address, 1581, The Engineer Office. 1581 A

GOOD All-round DRAUGHTSMAN REQUIRED for Factory in East Anglia.—Address, stating full particulars, 1649, The Engineer Office. 1649 A

HEAD DRAUGHTSMAN REQUIRED in Works employing about 800 hands in the manufacture of intricate and accurate machinery. Excellent opening for man possessing executive ability, with good experience in the designing of complicated mechanisms.—Address, stating age, experience, and salary required, 1620, The Engineer Office. 1620 A

JUNIOR DRAUGHTSMAN WANTED for General Engineering Work in South of England. Experience in Centrifugal Pumps and Refrigerating Work an advantage.—Address, 1609, The Engineer Office. 1609 A

REQUIRED by Large Firm of Constructional Steel Work Engineers in London, an experienced DRAUGHTSMAN, about 30 years of age, with sound technical ability, capable of designing Steel Work for Modern Buildings to comply with all the Building Acts, also to prepare quantities. Quick and accurate.—Address, giving full particulars of age, experience, salary required, and when free, P1579, The Engineer Office. Juniors and draughtsmen with mechanical experience are asked not to apply. P1579 A

FOREMAN REQUIRED for Fitting and Assembling Dept., Light and Medium Machinery. Only first-class men need apply. State full experience, age, salary.—Address, 1573, The Engineer Office. 1573 A

WANTED, RAIL SHOP FOREMAN for Glasgow area; must be accustomed to Light Railway Material, Turnouts, and Main Line Points and Crossings.—Address, 1614, The Engineer Office. 1614 A

FIRST-CLASS FOREMAN WANTED for Tunnel Driving.—Address, stating salary, with full particulars and references, 1628, The Engineer Office. 1628 A

WELDING FOREMAN WANTED for North England: an energetic foreman to Take Charge of the Welding Department of large Lap-welded Tube Plant, water gas process. State experience and wages required.—Address, 1615, The Engineer Office. 1615 A

WORKS FOREMAN REQUIRED for Manchester Firm of Constructional Engineers, 200/300 tons capacity. Must have held similar post as Foreman or Under-foreman and be well up in modern practice and piecework rates. Permanency for right man.—Address, giving full particulars, 1636, The Engineer Office. 1636 A

MESSRS. D. NAPIER and SON Have VACANCIES for a limited number of APPRENTICES, and are prepared to receive APPLICATIONS from the parents of well-educated youths who are not more than 16 years of age for an indentured apprenticeship covering a period of five years.—Apply by letter to 211, The Vale, Acton, W. 3. 1579 A

WELDERS, — OXY - ACETYLENE WELDERS WANTED for Tube Works, North England. Only men capable of making and finishing specials need apply. State wages and experience.—Address, 1616, The Engineer Office. 1616 A

SITUATIONS OPEN (continued)

REQUIRED for Tropical Service, Single Man as STEAM MECHANIC, preferably some experience Crane Work or Steam Shovel Excavation, to train as Steam Shovel Operator; salary 225 dols. U.S. Cy. per month; outfit allowance and passage paid.—Apply by letter, stating age and full particulars, to Z.O. 344, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 1673 A

COST CLERK WANTED by Marine Engineers in Shanghai. Must have had pre-war experience in Marine Engineering Repair Works. A shorthand typist preferred. Unmarried, Aged about 35. Salary commencing about £32 per month.—Address, detailing experience, P1587, The Engineer Office. P1587 A

SITUATIONS WANTED

A SPANISH and PORTUGUESE-SPEAKING British ENGINEER, with first-class credentials, proved ADMINISTRATIVE ABILITY and energy, with wide technical and commercial experience as Loco. Supt., Chief Engineer, Traffic and Assistant General Manager important railways, recently Director and General Manager of large Engineering, Transportation, Construction and Industrial Company, now closing down, OFFERS SERVICES in SIMILAR CAPACITY, preferably abroad.—R. GODFREY-ASTON (Lt.-Col.), Windyholme, Summerhill, Chislehurst. 1598 B

A.M.I. MECH. E. EXAM. LECTURER. Extensive maintenance experience, steam (coal and oil fuel) and Diesel, DESIRES SITUATION. Excellent references.—Address, P1593, The Engineer Office. P1593 B

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A Seven-Day Journal

Launch of H.M.S. Suffolk.

THE cruiser Suffolk was successfully launched at Portsmouth Dockyard on Tuesday afternoon by the Marchioness of Bristol. Among the spectators were Mr. Bridgeman, First Lord of the Admiralty, and all his colleagues on the Board, with the exception of Earl Beatty. The Suffolk, which is one of five cruisers authorised in the Navy Estimates for 1924–25, was designed by Mr. W. J. Berry, C.B., the Director of Naval Construction. Her keel was laid on September 30th, 1924, and it is hoped to have her ready for trials in the spring of next year. As the first cruiser built in this country to embody the considered lessons of war experience, and also to conform to the technical restrictions of the Washington Treaty, her design is understood to embody many novel features. The displacement at light draught will be 10,000 tons, but at full load, with fuel and reserve feed-water on board, she will probably be a 12-000-ton ship. Her turbine machinery is being supplied by the Parsons Marine Steam Turbine Company, Ltd. Steam will be generated in Yarrow small-tube boilers. The main armament is to consist of at least eight 8in. guns, a calibre which has not been represented in the British Navy for forty years. In range and penetrative power these weapons will surpass the 9·2in. gun with which our armoured cruisers of the pre-Dreadnought era were equipped. Four other ships of the "County" class are due to be launched at an early date, while two further vessels of the same type are being built at John Brown and Company's yard, Clydebank, for the Australian Government, and two more have just been ordered. It was officially stated last August that each "County" cruiser would cost £2,000,000, of which about £900,000 would be due to labour and £600,000 to material. The cost of maintenance in full commission will be £207,550 a year.

The British Electrical and Allied Industries Research Association.

THE British Electrical and Allied Industries Research Association, which held its fifth annual general meeting and luncheon at the Savoy Hotel, London, on Friday, February 12th, has undoubtedly done a good thing for itself in electing Mr. Ll. B. Atkinson as its new president. No greater advocate of research or more enthusiastic supporter and believer in new ideas could have been found, and it is not improbable that before Mr. Atkinson's term of office expires, the Association will have reason to congratulate itself on having made a wise selection. The speech which he delivered at the luncheon, and which we report on another page, should remove any doubts that may exist as to whether it is expedient to spend money on research in connection with the British Electrical and Allied industries. As Mr. Atkinson showed the credit for a very large proportion of the progress made in science and engineering is due to British scientists and engineers, and it is well within the range of possibility that if an adequate sum of money were devoted to research, striking developments might soon be brought about. No one believes that the present methods of generating and distributing electricity cannot be improved, or that nothing more remains to be discovered. There is little doubt in our opinion that the day will come when the existing methods of producing electricity will appear ridiculous. It is the intention of the Government to reduce the grant it has been making to the Association, and to discontinue it altogether at the end of five years, but it is to be hoped that before that time adequate funds will be forthcoming from other quarters.

Remarkable Tests of an Aeroplane.

IN our review of Aeronautics in 1925, published in our issue of January 8th this year, we included a description and general arrangement drawing of a very interesting two-seater military fighting aeroplane which had just been built by William Beardmore and Co., Ltd., Dalmuir. No doubt many readers wondered why in this case the interests of official secrecy should apparently have been ignored to such an extent as to enable us to publish details such as usually would not have been made public before the machine was at least two or three years old. The explanation is that the aeroplane, although representing Messrs. Beardmore's latest design, was built not for the British Air Ministry, but for the Latvian Government. The machine had not been tested at the time when we described it, but it has, we learn, recently been put through its trials by Captain A. N. Kingwill, Messrs. Beardmore's chief pilot, and has, by all accounts, acquitted itself in a remarkable manner. It was found, we are informed, that the machine had a ratio of top speed to landing speed exceeding 3 to 1, whereas the anticipated value of this ratio was not much more than 2½ to 1. In the course of the trials the machine was caused to dive at a speed of over 200 miles an hour, and immediately afterwards made to execute a loop. It was rolled and spun, made to reproduce the motion of a falling leaf and caused to turn a corner at high speed with the angle of bank almost vertical. Flying horizontally the engine was throttled down until the stalling angle was reached. The throttle was then closed and the control handle pulled right back. The machine took up an angle of about 60 deg. with the horizontal, and began to sink. Yet although it was in a fully stalled condition, its controls were still fully operative and could at will be used to rock the machine latterally or to cause it to pitch. At 1000ft. altitude the machine was made to climb quite vertically until it stalled and started to fall tail first. It was again shown that all the controls were still fully operative. In most machines a stall is followed by a side roll and nose dive, and for several years past a special committee has been investigating the cause of and cure for this frequently fatal phenomenon. With the new Beardmore machine a stall, the makers remark, becomes a safe and useful exercise.

The Projected White Star Liner.

CONSIDERABLE interest—indeed we might almost say excitement—has been occasioned in shipbuilding circles by the reports recently current that the White Star Line is contemplating the building of a new Atlantic liner of superlative tonnage and dimensions for its Southampton–New York service. At the time of writing the owners and Harland and Wolff, Ltd., the builders mentioned in connection with the projected vessel, have no statement to make in the matter. Although it is established that no order has been placed, we are given to understand that certain enquiries have been made as regards the preliminary design. It is assumed that the new liner would be larger than the Majestic or the American-owned Leviathan, with a probable gross tonnage of 60,000, a length of 950ft., and an estimated speed of 27 knots. It must be borne in mind that with present-day costs for labour and raw materials, the construction of such a vessel would run into close upon three million pounds, and from two to three years would be required in all likelihood to complete it. Again the important questions of harbour and docking accommodation have to be considered. In the reports referred to no indication was given as to the probable type of propelling machinery, but the success of the motor liner Asturias has recently focussed attention on internal-combustion machinery of large power. On the other hand, the progress made in steam turbine and marine boiler design since the machinery of the Majestic was constructed must not be overlooked.

The Annual Dinner of the Institution of Electrical Engineers.

ON Thursday, February 11th, the annual dinner of the Institution of Electrical Engineers was held in London, at the Hotel Cecil, the chair being occupied by the president, Mr. R. A. Chattock. Contrary to what many who attended probably expected, no new light was thrown upon the Government's electricity scheme, although in proposing the toast of the Institution, Mr. Chamberlain, Minister of Health, made reference to the Bill that is shortly to be introduced. The first sketch of the proposals, he said, had been welcomed by the public with a unanimity which positively alarmed him. From the layman's point of view it might be said that the Government's purpose was threefold—to provide for the concentration of production, for the pooling of power resources and the standardisation of equipment. If those things could be achieved some cheapening of electricity and an increased availability of supply might be expected, but such changes could not be brought about without interfering with local and personal interests. There would naturally be a certain amount of dislocation and change, and the abolition of existing offices. What the Government was aiming at, however, were changes in the national interest, and what benefited the community as a whole would, sooner or later, percolate to every individual part of it. In reply, the president said that the Institution was willing and anxious to do everything it could to assist the Government to further the interests which the Institution represented. Needless to say, this remark does not necessarily imply that Mr. Chattock agrees with the Government's proposals in their entirety.

Beet Sugar.

THE Government, it is stated, is making preparations for a considerably increased expenditure, during the coming financial year, in connection with the beet sugar industry. With the growth in the number of beet sugar factories and in the area of land under sugar beet, the sum required to meet the Government subvention must naturally increase, and no doubt the bulk of the augmented expenditure to be incurred will be accounted for in this direction. At the same time the Government has acquired or been presented with the British rights of the de Vecchis process under which the manufacture of beet sugar can be conducted right throughout the year, instead of being confined, as in the established process, to a "campaign" of a few months' duration. Some money will doubtlessly be expended on the development of this process, for a commission appointed by the Ministry of Agriculture recently expressed the opinion that a complete de Vecchis plant on a small scale, but on a factory basis, should be set up to test the process experimentally. If the new process should prove successful much capital outlay would be saved in the establishment of a factory designed to use it This fact, it would appear, is for the moment acting in some respects to retard the development of the beet sugar industry. At a meeting last week of the Shropshire National Farmers' Union, it was stated that those interested in the building of beet sugar factories were holding their hands for the time being in order to see before committing themselves to what extent the de Vecchis process will justify the claims made for it. The subject has also been debated recently by the Committee of the British Sugar Beet Society. This Committee has adopted the view that the de Vecchis process is still in the experimental stage, and that its commercial possibilities have still to be established. The known results achieved by the process, it is held, are not such as should discourage the investment of additional capital in the established methods of beet sugar manufacture, nor prevent sugar beet growers from entering into contracts with existing factories.

British Shipping in 1925.

THE annual report of the Chamber of Shipping of the United Kingdom, which was published on Monday last, is not a cheery document. An analysis of last year's shipping trade would seem to show that the depression which began in the second half of 1920 continued and deepened. Freights were lower in 1925, we are informed, than at any time within the last four or five years. The earnings of liners were often insufficient to cover voyage expenses, and to leave an adequate margin for depreciation and interest on capital, whilst cargo ships suffered by having to make more voyages in ballast. The report informs us that the accounts of eighty-five cargo ship companies show that on a total invested capital of £29,000,000 only a dividend of 3¾ per cent. was paid. An optimistic note, however, is sounded with regard to the age and quality of British ships, which are stated to be well above the average, thanks to the efforts made by shipowners to maintain and improve their fleets, even in the face of the unparalleled high costs of production. The world's tonnage has increased from 49,000,000 gross tons in 1914 to 64,500,000 tons in 1925, but trade has decreased, and is still appreciably lower than that of the pre-war year. Shipping which has been run under State subsidy has continued to flood the freight market. In some cases the application of the Trades Facilities Act to the shipbuilding industry has helped the shipbuilder, but has, at the same time, provided increased competition for British shipping. The only cure for the prevailing depression, says the report, is the revival of trade, which will best recover if it is unhampered by Government interference, trade restrictions or artificial stimulants.

The Kent Coal Field.

IN a parliamentary paper issued on Wednesday, giving particulars of the guarantees under the Trade Facilities Acts since last November, it was announced that the Treasury had agreed to guarantee, both as regards principal and interest, the sum of £2,000,000 to Pearson and Dorman Long, Ltd., for a period of thirty years for the purpose of aiding the development of the Kentish coalfields. The quantity of coal in the area is estimated at anything from 2000 to 9600 million tons, while something like 100 million tons of iron ore are estimated also to be in existence. The coal seams lie at a depth of 400 to 1000 yards, and vary from 3ft. to 9ft. in thickness. Ultimately the development schemes now in hand will, it is estimated, provide direct employment for 20,000 men.

The Shipyard Agreement.

As was confidently expected, the result of the ballot of the affiliated unions of the Engineering and Shipbuilding Trades Federation on the draft agreement for the settlement of disputes showed a large majority for acceptance. The actual number of the votes given was not made public at the York quarterly meeting, held on Wednesday, as the figures must first be referred to the Shipbuilding Employers' Federation. It is understood, however, that out of a total of nearly 12,000 votes, there was a four-to-one majority in favour of the peace proposals. We have previously referred to the scheme under consideration in a leading article, published in our issue of December 28th, 1925. It provides machinery for the settlement of disputes without stoppage of work by reference to a joint local conference, and, if necessary, in later stages to a general conference or to arbitration. Although the boilermakers and other unions not affiliated with the Federation did not take part in the ballot, the negotiating machinery will, it is understood, be available for all shipyard workers, and already ten trades organisations have indicated their willingness to use it, although they did not participate in the ballot.

Linoleum Machinery.

No. V.*

INLAID AND PRINTED LINOLEUM.

THE Walton system of making "straight line" inlaid linoleum, to which reference has already been made, involves the capital expenditure on a very costly machine, besides requiring a big outlay for each design made, and the natural result is that there are very few plants of this type in existence. On the other hand, the rate of output is very considerable—about a mile of linoleum a day—and when a machine has been set up to produce a really popular pattern the preliminary expenditure is no doubt justified.

The original Walton machines were made by Middleton's, the old Southwark millwrights and engine builders, who went out of business some time

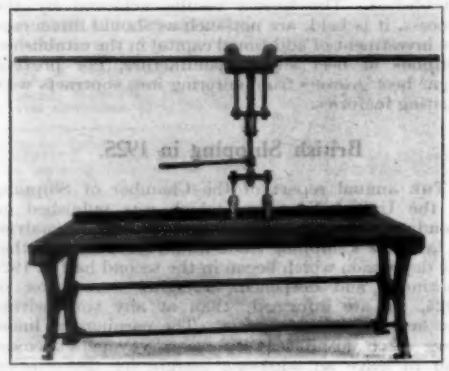


FIG. 28—HAND PRINTING PRESS—FARMER, NORTON

ago, but the machines are still running satisfactorily, and a new machine embodying the same principles has been built, and is being used by Barry, Ostlere and Shepherd, of Kirkcaldy. We have studied the working of these machines at some length, and although we are not at liberty to publish drawings of them, it is hoped that the following notes may indicate their essential features and the method of working.

The linoleum mixture is made up into sheets, or "blankets," of various colours by calendering, as in the hand-made process. These sheets are fed into the inlaying machine continuously as required, are cut up to form tesseræ, which are then arranged in place on the canvas backing automatically.

The pattern, as before, is built up of a number of rectilinear units, which may be hexagonal or square, except in "solo" patterns having curved contours. Solo patterns are not popular with linoleum manufacturers on account of the cost of preparing the machine to make them, and the possibility of the design not being favourably accepted by the buyers. On the other hand, the rectilinear styles can be altered comparatively easily.

The main part of the machine is a large cylinder, about 9ft. in diameter by 2 yards wide, which is covered with fine spikes like a sheet of card clothing. Round this drum the canvas is wrapped, with the spikes projecting through it. The spikes are for the purpose of holding the tesseræ in place, temporarily, as the material goes through the machine. The drum is mounted in bearings in heavy side frames, and is rotated slowly.

On the inlet side of the machine there is a set of rolls, about a foot in diameter, arranged one above the other round the circumference of the large drum. There is one of these rolls for each of the colours in the pattern. The blankets of the linoleum are led round these rolls separately, and are cut up into tesseræ by cylinders arranged between the rolls and the large drum.

The cutting cylinders are remarkable appliances, and on their careful preparation the success of the machine depends. Assuming that the pattern to be made is built up of little squares or hexagons, ¼in. across the faces, the whole surface of the cylinder, which is hollow, is drilled with holes about ¼in. in diameter and spaced ¼in. apart. One of these cylinders has as many as 60,000 holes drilled in it. Into these holes there are driven little pegs which project about ¼in. above the surface of the cylinder. The projecting part of the peg is square or hexagonal, as the case may be, and the pegs are slightly tapered, so that they

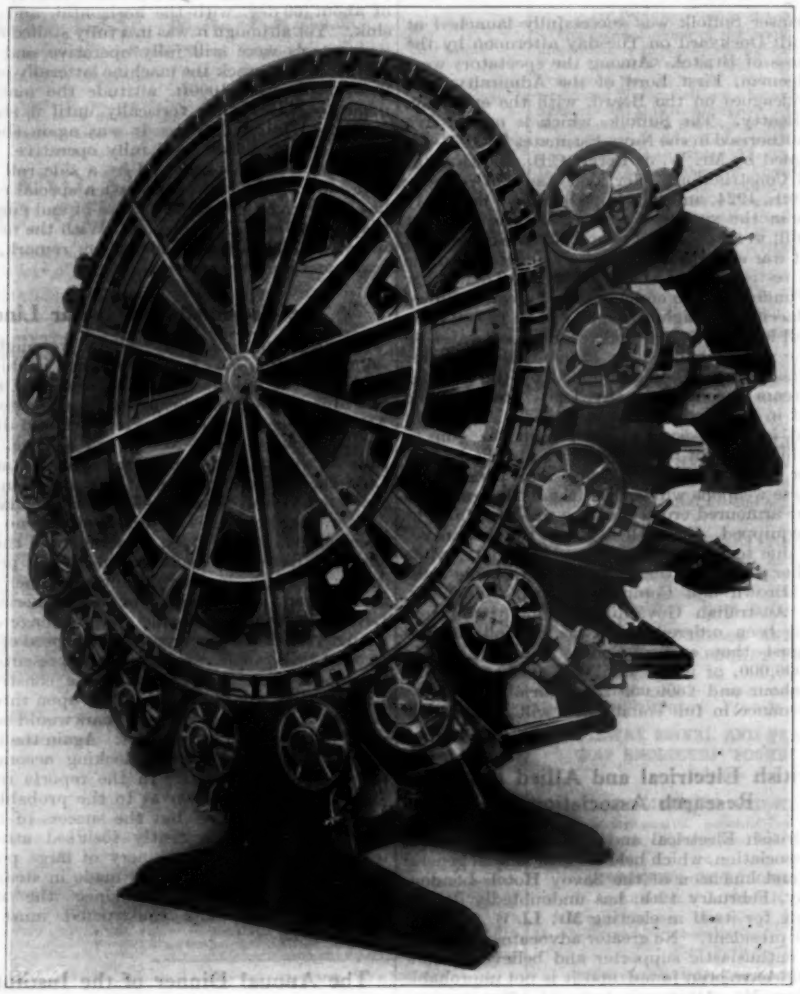


FIG. 31—TWELVE-COLOUR ROTARY LINOLEUM PRINTING MACHINE—FARMER, NORTON

FIGS. 29 AND 30—INSPECTION AND TAKE-OFF ENDS OF LINOLEUM INLAYING MACHINE—BARRY, OSTLERE AND SHEPHERD

* No. IV. appeared February 12th.

fit almost against one another all over the surface, with a slight crevice round each. Into these crevices there are driven pieces of thin spring steel, which project about ¾in. above the ends of the pegs. The result is that the outer surface of the cylinder appears as a honeycomb of sharp cutting edges, which, when the linoleum blanket is pressed on to it by the small roll, completely cuts up the material into small squares or hexagons. These little pieces are, of course, embedded in the honeycomb, from which they must be extracted for application to the canvas. For this purpose a little plunger is arranged in each of the cells, and has a stalk running through the peg below into the interior of the cylinder.

Inside the cylinder there are two small rolls running the full length and geared together, so that they rotate at the same peripheral speed as the cylinder. They do not rotate round a common axis with the cylinder, however, as their bearings are in the fixed framing. The surfaces of these rolls are provided with pegs and hollows, corresponding with the pattern, which operate the plungers by their inwardly projecting stalks.

The action of the apparatus is as follows:—The honeycomb, having been completely loaded with little tesseræ of linoleum, rotates until the plungers meet the first of the two internal pattern rolls. The pattern on this roll is what may be described as a negative; that is to say, it corresponds with those parts of the design where the colour in question is not required. The result is that the plungers push out of the honeycomb all the tesseræ not needed. These pieces fall into a conveyor and are taken back to the mill to be made up into blanket again. It is here that the reason, mentioned in the previous article, why the machine is not well adapted for grained designs becomes obvious, as the rejected material would lose the grained effect in being re-milled and would come back as a neutral tint.

The honeycomb cylinder goes on rotating until the plungers come to the second internal roll, which is arranged opposite the point of contact between the cylinder and the large drum. The pattern on this roll is a positive and the tesseræ which have been left in the honeycomb are consequently pushed out on to the spikes projecting through the canvas. A second blanket is operated on by another cylinder for a second colour, and so on until the whole pattern has been built up. In some cases there may be as many as five colours, and it will be readily understood that the expense of building up all the cylinders for an elaborate design is a very costly matter, while it may take eighteen months to prepare them.

In the case of the old machines at Kirkcaldy, the linoleum is inspected on the taking-off side of the large drum, and several girls are stationed on a bridge across the machine, with supplies of tesseræ to make good any faults which the machine has produced. Occasional faults are, of course, inevitable in such a complicated mechanism, which has to run continuously and cannot be stopped to remedy any slight defect until the day's work is done. In the new machine the linoleum goes over a second drum, which can be plainly seen in Fig. 29, not quite so large as the first, and is thus well exposed for inspection and mending.

After having been inspected, the linoleum goes on to a heavy hard-rubber band, about ⅛in. thick, and is subjected to heavy pressure between steam-heated calender rolls. The object of the rubber band is to provide a slightly yielding bed which will accommodate any slight unevenness in the thickness of the material. The linoleum is welded together by the calendering, and, after passing over the water-cooled drum—shown in Fig. 30—is wound up in large rolls ready to go to the maturing stoves.

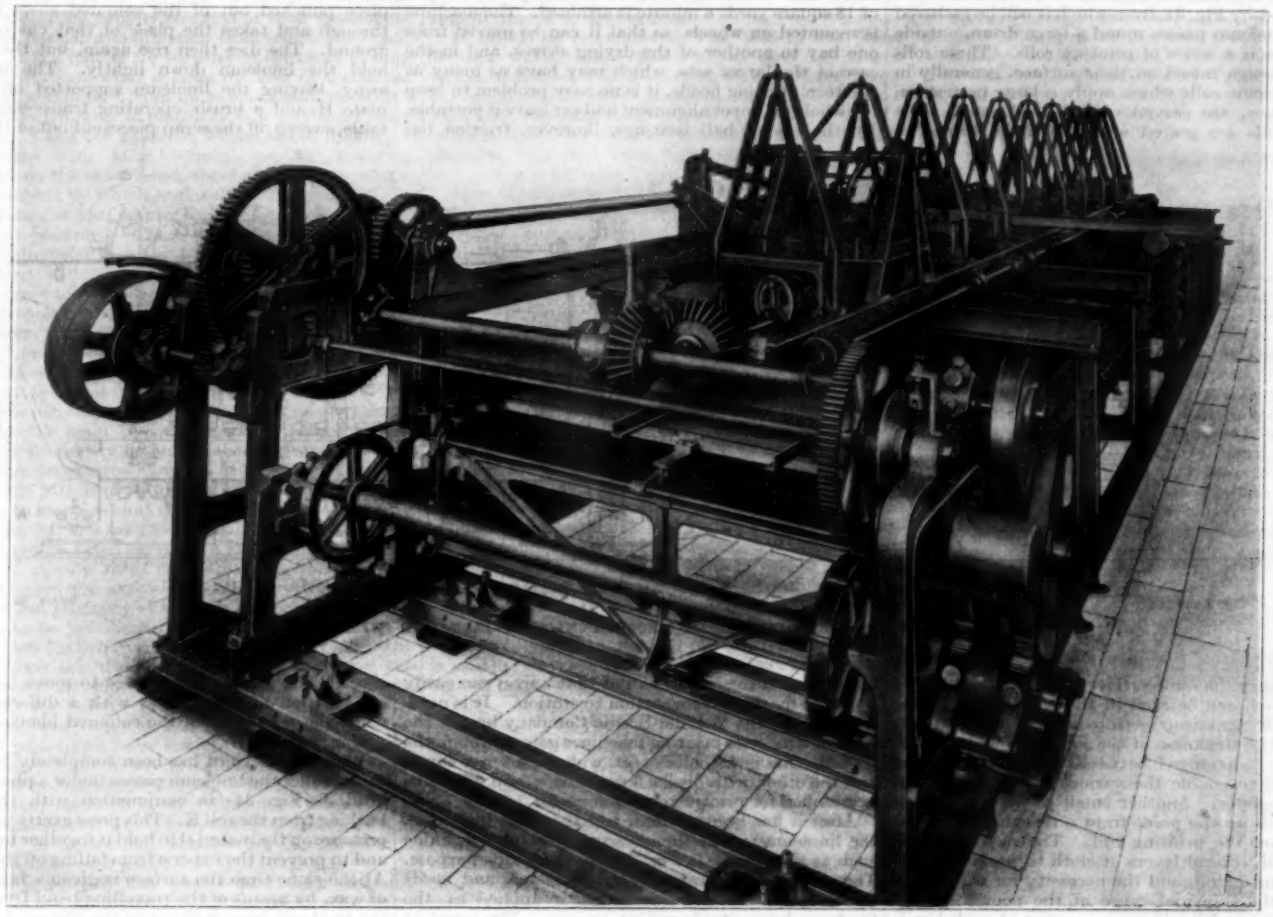


FIG. 32—LINOLEUM PRINTING MACHINE FOR 18in. BLOCKS—MELVILLE-BRODIE

PRINTED LINOLEUM.

Linoleum is ornamented by printing with oil paint both by hand and by machine. The best qualities are hand printed, and although the apparatus used seems very crude, astonishingly good results are got by experienced men.

The paint is applied by blocks which are generally about 18in. square, so that they combine to cover the width of the material without overlapping. The blocks are mostly of pear-wood and are cut up on their faces into a great number of little squares about ⅛in. across. These squares are cut away where necessary to leave the pattern in relief.

The printers generally work in a gallery round the top of a tall building, and have in front of them a table over which the linoleum is led. The finished part then hangs down in the well of the building, and is left there for the paint to dry. Above the table there is a joist on which there runs a press such as that shown in Fig. 28, which is by Sir James Farmer, Norton and Co. The press, it will be seen, is quite a simple affair, and is used to squeeze the blocks down on to the linoleum. Behind the man there is a table on which a boy spreads patches of the various colours of paint. In some works a long table is used, while others favour a round table on a pivot.

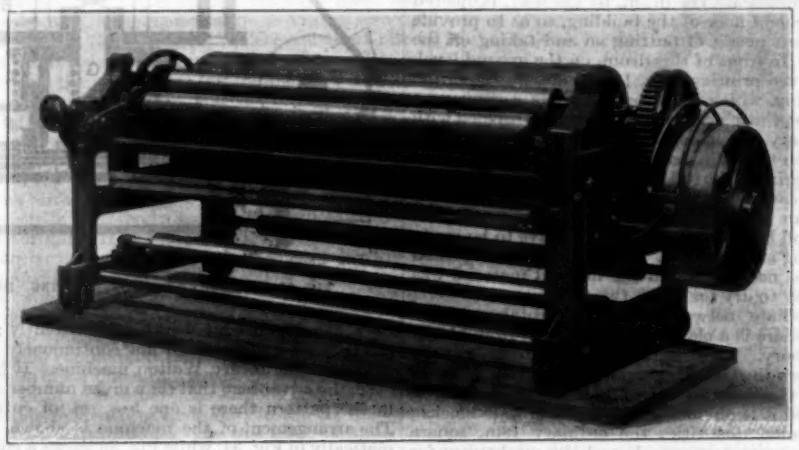


FIG. 33—LINOLEUM VARNISHING MACHINE—BERTRAMS

The printer takes a block, presses it lightly on the paint, and transfers it to the linoleum, where pegs on its edge register against stops on a fence to insure the block being in position. The press is used to squeeze the block down, and the process is repeated with the other colours to complete the pattern. Finally a "smasher" is used to spread the colours evenly over the surface. A smasher is a block with all the little squares left full height, so that it bears equally all over, and makes the patches of paint flow

out to meet one another without any dividing blank between.

At the opposite end, in the scale of grades, to hand printed linoleum there is rotary machine printed stuff, and it is only the very thin varieties which are printed in this way, because a really sharp definition cannot be obtained. The rotary machine has, however, a very high output by comparison with other printing processes.

Rotary linoleum printing machines very closely resemble those used in the calico trade, and consequently do not require any very detailed description. A twelve-colour machine, by Sir J. Farmer and Co., is illustrated by Fig. 31, from which it will be gathered that the linoleum passes round a large drum, outside which there is a series of printing rolls. These rolls have the design raised on their surface, generally in brass, but some rolls which apply a large proportion of the colour, are cerved out of hard wood. The printing rolls are geared with the main drums, so that they have the same surface speed, by the toothed wheels, which can be seen in the engraving. These wheels have extra deep teeth to accommodate adjustments for the thickness of the linoleum, and a worm connection is arranged between the wheel and the roll spindle to enable the various rolls to be set in accurate register. Another small roll and doctor is used to pick up the paint from a trough and spread it evenly on the printing roll. The main drum is clothed with several layers of cloth to provide a soft bed for printing on, and the necessity for this bed is probably the principal cause of the poorer quality of rotary printed linoleum, as compared with hand-printed stuff. Rotary printing machines are generally mounted on wheels so that they can be moved from bay to bay in front of the stoves in which the paint is dried.

One of the most remarkable rotary printing machines ever used in the linoleum trade was made by J. Copeland and Co., of Glasgow, to the designs of Mr. J. Wright, of Kirkcaldy, and was put to work in the factory of Barry, Ostlere and Shepherd. It had a great drum 26ft. 9in. in diameter by 12ft. 9in. wide, built up on steel spiders with wooden lagging. Round this drum there was wound a complete length of 25 yards of linoleum. The drum, by the way, projected into the second floor of the building, so as to provide a convenient means of putting on and taking off the linoleum. In front of this drum, on the ground level, a set of seven printing rolls, 18in. wide, was mounted in a housing, which could be slid along a transverse bed. The printing rolls were, of course, provided with the necessary colour boxes and doctor rolls, and were geared with the main drum. When a strip 18in. wide had been printed the full length of the piece, the printing rolls came opposite a gap where the linoleum ended. An automatic gear then came into action and the roll housing was moved sideways to be ready for printing another strip. The process was repeated as often as necessary, and the finished material was taken away to dry for about two weeks.

Intermediate between hand and rotary printed linoleum there is a class which is printed from blocks by machinery. The blocks are similar to those used for hand printing, but they are sometimes made the full width of the strip to be printed. If a long run is anticipated it is obviously better to use wide blocks; but for small quantities the ordinary 18in. square blocks are more economical, and the mechanism for manipulating them is of a highly complex nature. A machine of this class by the Melville-Brodie Company is illustrated by Fig. 32. In it there can be seen, running down the centre of the machine, the carriers for the blocks, while below, inside the framing, there is the printing table over which the linoleum is drawn.

The blocks are given a vertical movement by cams on a shaft running through all the carriers, which is driven by the bevel gearing seen in the foreground, and they are travelled from station to station, sideways, by the crank mechanism at the back. This gear moves the whole set of carriers 18in. across after each printing stroke and proper alignment is assured by a series of pinions, on a shaft, which engage with transverse racks. After the block has made its impression a colour platen is run beneath it and, by means of a doctor roll, gives the block a fresh supply of paint, at the same time the linoleum is fed forward, by means of spiked steel bands on either side of the table, to the extent of the width of the blocks. The last block of the row is always a smasher, but sometimes a smasher is used after the application of every colour.

Machines of this class turn out about 3½ square yards of printed linoleum a minute, but when a block the full width of the strip is used, and the transverse movement is consequently unnecessary, an output of 18 square yards a minute is attained. The machine is mounted on wheels, so that it can be moved from one bay to another of the drying stoves, and in the case of the larger sets, which may have as many as eighteen printing heads, it is no easy problem to keep the whole in proper alignment and yet leave it portable. By the use of ball bearings, however, friction has been reduced to such an extent that a man can easily push the machine from station to station. It is noteworthy that the Melville-Brodie Company has, at the present time, two printing machines going through the shops. One is for blocks 6ft. wide with ten colours, and the other, with blocks 3 yards wide, and 25 heads, is intended for printing carpet squares.

After it has been printed, and the paint has dried, the linoleum is sometimes varnished, and a machine such as that shown in Fig. 33 is used for this purpose. The machine illustrated is by Bertrams, and needs little description, as the varnish is applied to the linoleum by a simple rolling process. The speed of operation is from 15 to 20 lineal feet per minute.

Reverting again to machines for making straight-line inlaid linoleum, we may say that one of the latest machines of this type was invented by Messrs. Ellis and Westle, of Eastgate House, Gloucester, and is now being experimented with on the Continent. It is fully automatic, and works intermittently; that is to say, step by step, and not continuously as is the case with the rotary Walton machine. It has, however, the advantage that for a given number of colours in the pattern there is one less set of cutting dies. The arrangement of the machine is shown diagrammatically in Fig. 34, while Fig. 35 shows a cutting die.

Linoleum of the various requisite colours is fed into the machine in the form of blankets, as before described, directly from the calendering machines on the floor above the inlaying machine. The colour, which is to form the background of the pattern, is, however, supplied from a roll—shown at A—at one end of the machine. This blanket is led up over a guide roll and along the top of a long table. The other colours are led down from above, between guide rolls, and underneath the stamping heads B B B. After passing under the stamp the blanket goes to a re-winding drum, such as those indicated at C C C, where the scrap is rolled up for subsequent re-milling.

The process of inlaying is really a matter of the substitution of pieces from the coloured blankets in the place of pieces punched from the ground sheet, and is effected by tools in the press heads, as shown in Fig. 35. In this view it will be seen that the ground sheet A and the coloured blanket D are led over a table E beneath a set of cutting dies F, which are fixed in the stamping head B. Both the head and the table are connected with cam motions to give them a vertical stroke, and the cutting dies are provided with spring-operated stripping plungers G G.

The process is as follows:—At a time when the sheets of linoleum are stationary the dies come down and cut right through the two sheets at once. The piece punched out of the coloured sheet is pushed through and takes the place of that cut out of the ground. The dies then rise again, but the strippers hold the linoleum down lightly. The table falls away, leaving the linoleum supported on the grid plate H, and a brush, operating transversely to the table, sweeps off the scrap pieces cut out of the ground sheet. The ground is now free to move forward for a repetition of the process with a different colour, while the remainder of the coloured blanket is rolled up for re-use.

When the pattern has been completely built up in this manner the linoleum passes under a plain pressing head J—Fig. 34—in conjunction with the hessian backing from the roll K. This press exerts just enough pressure on the material to hold it together temporarily and to prevent the tesseræ from falling off the backing. At the same time the surface is given a faint coating of wax, by means of the travelling band L, to prevent the linoleum from sticking to the platen of the press.

The strip of material is carried, as a loose loop, over a steam-heated radiator M to a powerful hydraulic press, of which the platens are steam heated, for final consolidation. The object of providing the loose loop is, of course, to accommodate any inequalities in the rates of feed through the inlaying machine and through the press. It is too early yet to give an opinion on the capabilities of this machine when it has been fully "tuned up," but it appears to have good features in several directions, especially where solo designs are being made.

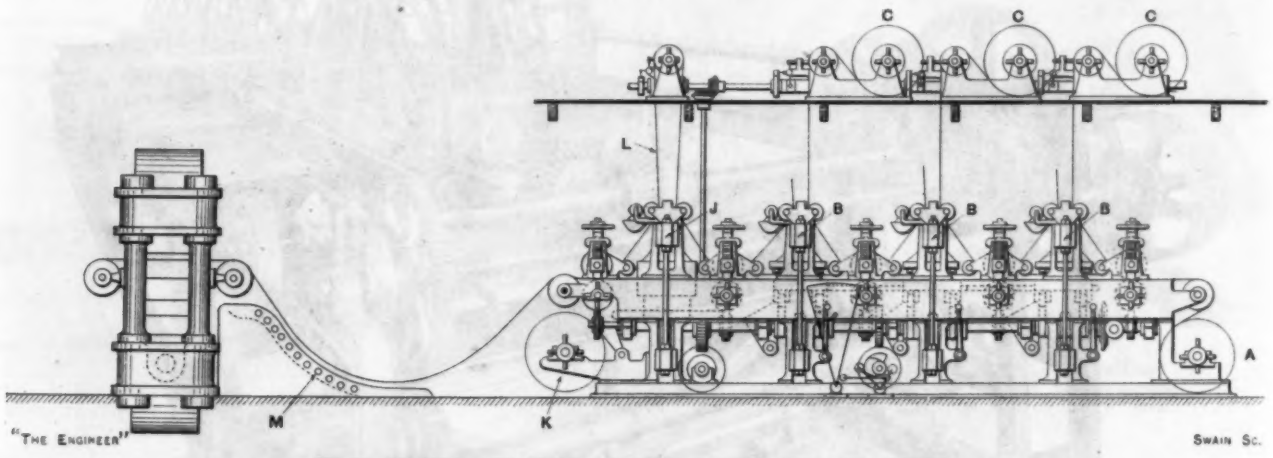


FIG. 34—STRAIGHT-LINE INLAID LINOLEUM MACHINE—ELLIS AND WESTLE

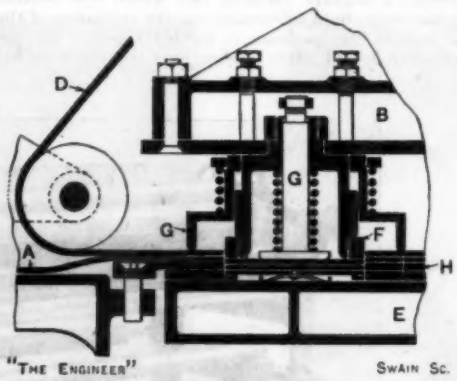


FIG. 35—ARRANGEMENT OF CUTTING DIE

Notes on British Railways by a Continental Engineer.

No. III.*

TERMINI AND STATIONS.

IF the large British stations are not—with the exception of St. Pancras and several others—striking buildings, and cannot vie, in that direction, with many European and American stations—by the way, is it necessary for a railway station to be imposing?—their interiors are arranged in an extremely practical manner from the points of view of the comfort of travellers, the movement of trains, and of dealing with luggage. This luggage question, which is one of the most complicated and difficult problems on continental railways, seems to be non-existent in England, so much is it simplified by the absence of "octrois" or town dues. I confess that, personally, I much prefer a commodious station, with high, long, wide and well lit platforms, which are kept perfectly clean, and are never blocked up, and on which the traveller is not constantly having to get out of the way of trucks carrying baggage or mail bags—to the finest exterior which can be devised. The great stations in Germany, for instance, can only impress the unthinking public, and one cannot help feeling that the sums of money swallowed up in building them might have been better spent in improving the rolling stock and the permanent way.

Thanks to it being possible for carriages and taxi-cabs to draw up in line alongside the platforms, to the absence of registration—properly so-called—

* No. II. appeared February 12th.

of the baggage, and octrois, and thanks to the large number of porters available, it is only a matter of a few minutes at those London termini which have not got Customs Houses for the passengers alighting from a long-distance main line train to get their luggage and drive off.

Furthermore—and this is a matter which has a most important bearing on the amount of traffic with which a terminus can deal—many of the British stations have, at a distance away of a few miles, often less, large sidings or sheds to which empty trains can be sent during the slack times of the day, so that the roads in the stations are rarely occupied for very long. In some of the London stations, with large suburban traffic, trains are rapidly emptied of their passengers, and sent back in the direction from which they have come. It is a matter for surprise in the cases of some of these stations what a large number of trains can arrive at and depart from quite small stations with a very limited number of platforms in a very short space of time. Take, for example, Broad-street Station.

In some very large termini, as, for instance, Victoria, on the other hand, there are very convenient arrangements by which engines can be detached from their trains, or two trains can stop at or depart from the same platform. These advantages are obtained by the provision of a third line of rails between the other two, and connected to them by conveniently placed cross-over roads. Many English stations, and not the most modern either—King's Cross, York, &c.—have very long platforms which can accommodate two trains, even long ones, at the same time. In such cases the entrances and exits are often arranged at about the middle of the length of the platforms. In some termini there is only one departure platform for main line trains, notwithstanding the fact that there may be only a short interval between successive departures. In such cases the empty trains only come into the station a short time before they are due to start, so that their stay is never long.

To sum up, it is only very rarely that empty trains are allowed to stand even for a short time in British termini; at any rate, on the running roads, which are only used for arrivals and departures. In fact, there is less tendency than there is elsewhere for the termini to be fan-shaped in plan.

In most British termini of any importance, the buffer stops are fitted with hydraulic cylinders, the employment of which cannot be too highly recommended, for they prevent many slight buffer accidents, and result in the saving of money, since injured passengers have not got to be compensated. Trials carried out in my presence showed that these hydraulic buffers are absolutely efficient at a speed of 20 miles per hour. It is very difficult to explain why such an accessory, which is as cheap to install as it is effective in operation, should be, comparatively, unknown in foreign parts.

There is scarcely any smoke in British stations, thanks to the arrangements for smoke consumption in the engines, of which I make mention elsewhere, and if there is a tendency for smoke to be produced, the blower is put to work more or less strongly.

Turntables have never been used on the running roads of English stations. At the present time they have been done away with throughout the Continent as being out of date, for they cannot be used for long wheel base vehicles; as a matter of fact, their existence delayed for some time the lengthening of wheel bases. For a long while, however, they were used to transfer coaches from one road to another in large stations so as to meet the traffic requirements of the moment, a thing which the British companies only find it necessary to do very rarely, since they generally foresee what is likely to be needed. Their ideal has never at any time been to reduce to a minimum the dead weight of their trains, and nowadays on the Continent the contrary tendency is much lessened by the putting in service of powerful locomotives which are capable of hauling the heaviest trains. Steam-driven or electrically operated traversers for modifying the composition of trains are still to be found in some Continental stations, but their abandonment is only a question of time. It is, in fact, an anachronism which never had any vogue on English lines, on which all shunting is effected, and very quickly too, by means of cross-over roads and points.

In many goods stations on the Continent turntables are still to be found, but the turning round of the vehicles is most often done by electric capstans. This arrangement, which has to be put up with because it exists, is due to the restricted area originally obtainable in the hearts of large towns, the turntable lay-out taking up less space than anything else; but it is a prehistoric method, which has hindered the development of the bogie truck. It is no longer used, and new sorting yards, in France and elsewhere, are built on entirely modern lines. Shunting by means of points and crossings is particularly convenient and quick in a country like Great Britain, where, as I point out elsewhere, it is carried out with the regulator well opened, and with neither whistle-blowing nor verbal orders.

Thanks to the number of companies having networks of lines round and connecting with the large towns—especially the seaports—the latter are particularly well provided with traffic facilities. Numerous lines, some of them having four sets of lines, have access to the large towns and to London. Goods trains are generally not allowed to pass through the active parts of passenger stations of some importance, but are made to pass outside them.

A weak point of the termini and of the large through stations is that the refreshment rooms in many of them are much smaller and less well equipped than those on the Continent, such, for example, as that at the P.L.M. or P.O., &c., termini in Paris. But that defect has been partly compensated for by the fact that on most expresses, excepting night trains, there are dining cars.

In a word, the large English termini have not so much been built with a view to catching the eye as to meet practical conditions which the traveller rapidly learns to appreciate.

It should be remembered, too, that it was Great Britain which, sixty years or so ago, introduced terminus hotels. She no longer, by any means, holds the monopoly in that direction, but if some of her hotels of this class may appear to be somewhat out of date, they can at any rate claim to have been pioneers, and of a very high class for the time at which they were built.

Most interesting features are the small wayside stations, which are sometimes real cottages, always well kept and neat, with everywhere, without exception, raised platforms, and nearly always a bridge for crossing the lines. That is unique.

Goods Stations.

Of goods stations and yards in Great Britain I do not propose to say much. No country, I believe, possesses in its industrial and mining districts, a more extensive equipment of sidings. In this case again, it must be remembered that England was the country of origin of marshalling yards which are now to be found in all other countries, often on a more pretentious scale, but none of them more practically laid out. Shunting is effected rapidly, and is, most generally, carried out by a system of signalling which is similar to that used for the running lines and controlled from raised cabins so that a comparatively small staff is required. With a given area, a British marshalling yard can pass through more traffic in a given time than similar yards in any other country, except perhaps in the United States.

The mechanical equipment of British goods stations is usually very complete, hydraulic, electric or steam cranes, traversers, &c., being provided.

Running Sheds.

In Great Britain rectangular running sheds seem to be preferred to round-houses. Which of the two is the better is, doubtless, a point for discussion, but recent experience would seem to indicate that round-houses are the more practical if engine turntables of sufficient diameter are employed. Rectangular running sheds have the disadvantage that engines get imprisoned or have to be sent into the shed in the order in which they have to depart, which is not always an easy thing to do; or they necessitate frequent shunting, often of several locomotives, in order to let one out, and to turn them round separately. On the other hand, they are more easily arranged alongside the lines near stations.

In the United States round-houses are almost universally used, and they are beginning to come into favour again on the Continent, as the result of the recent adoption of turntables of large diameter. The old turntables delayed for too long the introduction of locomotives with long wheel bases and high capacity tenders. In this direction it appears to be undeniable that Great Britain is rather behind. For more than twenty years the Italian railways have had turntables 66ft. in diameter, while in France some of the lines have 75ft. diameter tables, and the United States of America have gone still further. That is, at one and the same time, the result of the employment of huge locomotives and the reason why they could be built. These turntables are of the American type, and are balanced on their centre pivot when the locomotive is in the desired position. They are operated by electric tractors on a circular rail. Engines with very long wheel bases and weighing 200 tons with their tenders can be very quickly turned. If the turntable is of too small diameter the tenders have to be uncoupled and turned separately, which is manifestly a waste of time. The English companies would probably do well to study what is being done abroad in this direction.

We do not deny that, particularly in France, rectangular running sheds are still the more numerous on certain lines, but a movement in favour of round-houses, or of semi-round-houses, alone or combined, is observable, evidently as a corollary to the provision of large diameter turntables. In this case, contrary to what I have said elsewhere regarding stations, shunting with the aid of points and crossings is less advantageous, first because tender engines must be turned round in any case, and secondly, because turntables really correspond to a system of points giving n directions.

British running shed yards occupy a much smaller area than do those of the French lines, for example, because they do not have to accommodate huge stocks of coal, in case of possible mobilisation, and because of the distance that some French yards are from the coal mines. Whereas engine sheds in France, even those of moderate importance, frequently have a stock of several thousands of tons of fuel, most yards in Great Britain receive their supplies of coal from day to day, so to speak, which has certain advantages, among others the less handling of the fuel entailed, for in well-equipped installations it can be delivered directly into the tenders of the engines by coaling plant. On the Continent, on the other hand, the fuel has first of all to be stored on the ground and then, later, lifted and deposited on the tenders. Except with briquettes, this operation is performed by means of steam cranes. All the same, there are, in France, platform installations to which the fuel is taken from the heaps in the store yard by means of electrically-operated overhead transporters, and delivered directly into the tenders; but, on account of the coal bonus, the fuel has all to be weighed or gauged in baskets, shovels or trucks of accurately known content. All the foregoing leads to the conclusion that the wealth of good coal possessed by England and her situation as an island simplify everything in connection with railway operation.

British Industries Fair.

No. I.

THE seventh British Industries Fair, which was opened on Monday, the 15th inst., and will remain open until the 26th, has reverted to the old arrangement of being held simultaneously in Birmingham and London, and although the buildings at Castle Bromwich have thus been relieved of the lighter exhibits from the White City, Shepherd's Bush, the space at the Midlands show is more fully occupied than for some years past with things of a more direct interest to engineers. It almost seems, in fact, that the Fair has been given a new lease of life, and has escaped the fate of gradually fading away which recent shows led one to expect.

In many ways the show closely resembles those of the past few years, and especially so in the fact

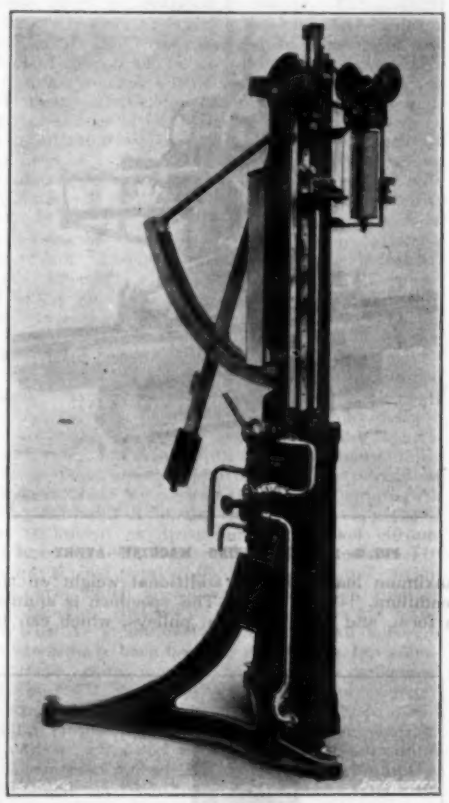


FIG. 1—RUBBER TESTING MACHINE—AVERY

that gas and oil engines in running order form a very prominent feature. There are, however, several new stands, while some of the old friends have disappeared; but, over and above all, one of the outstanding features is the inclusion of a much larger proportion of electrical exhibits.

Another peculiarity of the Fair is the large proportion of technical men on the stands, who are in a position to discuss theoretical matters broadly and not merely to tell their visitors that, for instance, their engines have cast iron bedplates and gunmetal bearings.

We start below to describe some of the exhibits, but make no effort to take them in any special sequence, and merely pick them out haphazard as we happen to have visited the stands.

On the stand of W. and T. Avery, Birmingham, there are, besides the usual assortment of weighing machines and weighbridges, a number of testing machines, several of which we illustrate. That shown in Fig. 1 is for testing rubber in tension, and is of the hydraulic type; the ram, or rather cylinder, which can be seen

in the front of the machine, is, however, large enough to produce the necessary load with the water pressure in the ordinary district mains. The load applied

FIG. 2—IZOD TESTING MACHINE—AVERY

to the specimens is indicated by a weighted pendulum swinging within a quadrant, which is graduated in kilogrammes with subdivisions of one-tenth. The

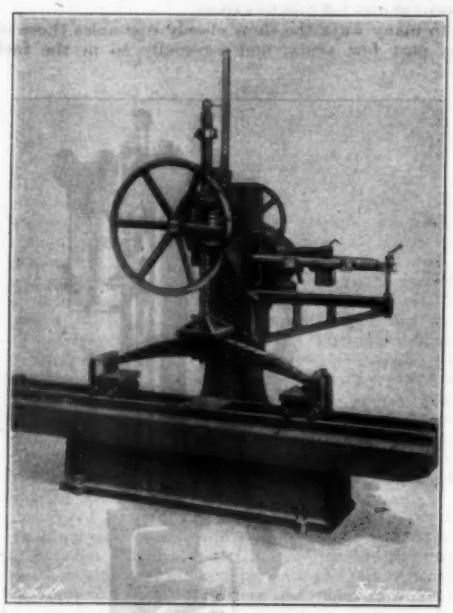


FIG. 3—SPRING TESTING MACHINE—AVERY

maximum load, with an additional weight on the pendulum, is 100 kilos. The specimen is annular in form, and is mounted on pulleys, which can be rotated so that the specimen can be kept in motion and the load applied uniformly. An autographic recorder is fitted for drawing a diagram and showing the mechanical hysterisis of the material, while there is a scale for indicating the percentage elongation.

The Izod impact testing machine—shown in Fig. 2—needs little description, as the type is familiar to most engineers. That exhibited strikes a blow of 120 foot-pounds, and a specimen 10 mm. square is used, while a smaller machine, with a blow of 23 foot-pounds for specimens 10 mm. by 5 mm., is also made. The motor car spring testing machine—illustrated by Fig. 3—is capable of exerting a pressure of 3 tons, and the steel-yard for balancing the load is graduated in 2 lb. divisions. An electric motor working a nut or a screw is used to apply the load quickly, and is controlled by a switch, which can be set to stop the motor at any predetermined load. The hand wheel can then be used for a final adjustment to allow for slight individual variations in the springs under test. Provision can also be made for the testing of quarter elliptical springs, either singly or in pairs, and adaptations for testing coil springs in tension can also be arranged.

On the stand of the National Gas Engine Company,

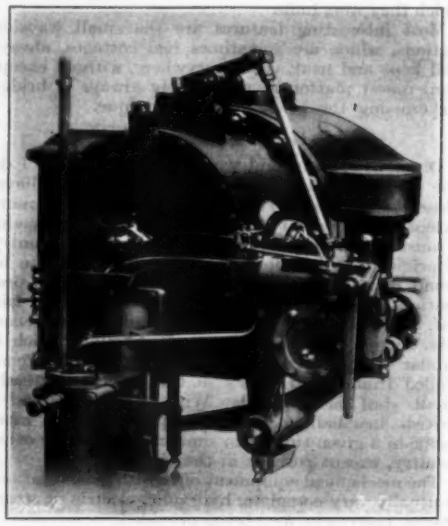


FIG. 6—66 H.P. HEAVY OIL ENGINE—NATIONAL

Ltd., of Ashton-under-Lyne, there is shown a horizontal heavy oil engine capable of developing 66 brake horse-power, the back end of which is illustrated by the engraving—Fig. 6. It will be noticed that the governor gear, fuel pump, &c., are all arranged in a very compact manner, but the various parts are, nevertheless, easily accessible. The makers claim that the fuel consumption of these engines compares favourably with that of Diesel engines, specially on light loads, and that it ranges from 0·42 lb. to 0·48 lb. per brake horse-power per hour when running at full load and using oil having a calorific value of some 18,000 B.Th.U. per pound.

The most interesting exhibit on the National stand is, however, one made in conjunction with the Austin Lighting Company, Ltd., which comprises two small electrical plants arranged to demonstrate the operation of an automatic engine-driven substation for improving and facilitating direct-current distribution. In the equipment shown—which is illustrated in Fig. 3—a 3 kilowatt set represents the main power station, and a larger set of 6 kilowatts represents the sub-station. The latter is arranged to start automatically when the load assumes a predetermined figure. In practice this load would represent a figure at which the potential drop on the feeder became as great as is desirable. When this condition of affairs is reached the sub-station plant starts up automatically and supplies current to the area, the engine running at full load and the surplus current being fed back towards the main station. The plants exhibited are of a type which is used for lighting country houses, &c., and the electrical equipment may be automatic, semi-automatic or hand controlled. Various sizes are made by the company from 1½ kilowatt upwards, and are suitable for running on petrol, paraffin or towns gas. Those intended for running on paraffin are arranged to start on petrol and to change over to paraffin after the engine has been running a few minutes.

Appropriately to the exhibition of such small electric lighting sets, the Chloride Electrical Storage Company has a stand on which there is shown a

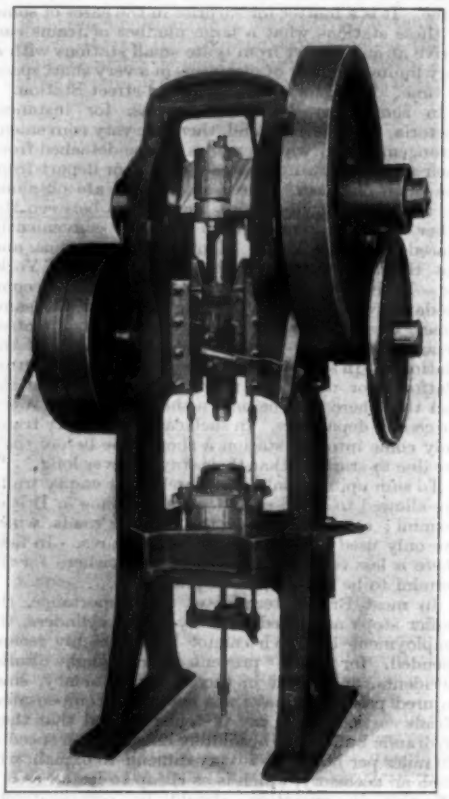


FIG. 7—PRESS FOR PLASTIC MATERIAL—TAYLOR & CHALLEN

variety of secondary batteries, which include some specially designed for radio work in units of 20 and 24 volts, mostly in glass boxes, Exide-Ironclad batteries for traction service, the characteristics of which we have described already, special cells suitable for miners' hand lamps, and similar purposes, and batteries for train lighting sets. Although some think that the day of the storage battery as part of the equipment of a large power station is now past, the Chloride Company still makes batteries of large capacity as is evidenced by a number of photographs on the stand.

One usually expects to find on the stand of Taylor and Challen, Ltd., Derwent Works, Birmingham, either something novel in the way of pressed work or the machines used for producing the finished article. Fig. 7 shows one of the latest presses produced by this firm, which is used for making articles out of plastic material. The material to be operated upon is kept warm in any appropriate apparatus, and the requisite

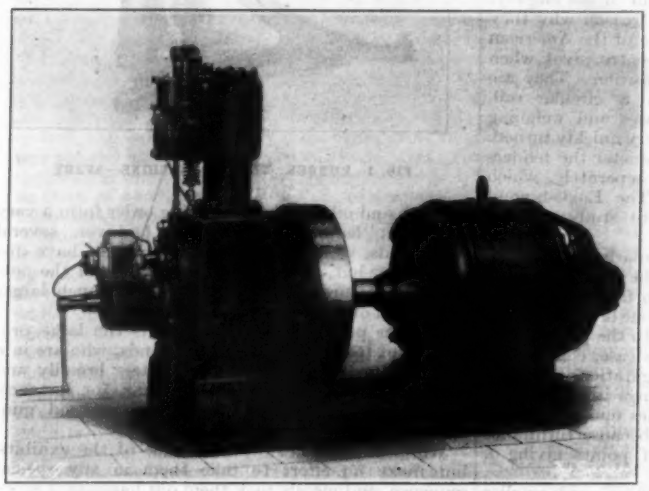


FIG. 4—3 KILOWATT ELECTRIC LIGHTING SET—NATIONAL

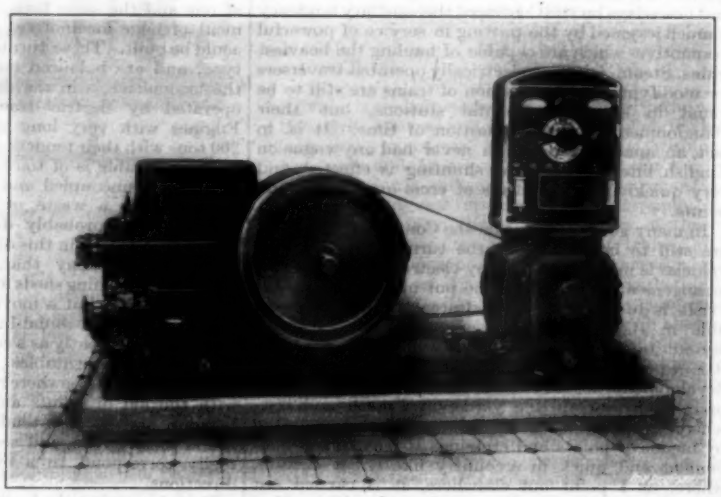


FIG. 5—1½ KILOWATT ELECTRIC LIGHTING SET—CROSSLEY BROS.

amount of it having been put into the die, the machine is started up by means of a hand lever. The press stops at the bottom of the stroke with full pressure on, and a compensating connecting-rod is provided and allows for any little variation in the amount of material used. This rod also gives the extra squeeze at the bottom of stroke necessary to produce the finish required in this class of work. On again depressing the hand lever and putting an extractor lever in position, the machine returns to the top of its stroke and brings the completed article out of the die ready to be taken away. The other new press on this stand is intended for producing hot brass pressings at one operation from, for instance, a round piece of Delta metal. The machine runs at from 50 to 60 strokes per minute, and it is claimed that it is possible to attain a much larger output on this type of press than with a drop stamp or screw press.

The engines on the stand of Crossley Brothers, Manchester, are noteworthy on account of the fact that they are all shown running. They include a horizontal cold-starting oil engine of 31 brake horse-power, capable of working on the cheapest grade of fuel oil, of which, it is claimed, the consumption is only 0·45 lb. per brake horse-power per hour. The most novel engine on this stand is, however, a 1½ kilowatt electric-lighting set, of which we give an illustration in Fig. 5. It comprises a 3 brake horse-power totally enclosed paraffin engine coupled by belt to a dynamo designed to generate current at from 50 to 70 volts. The switchboard, it will be seen, is mounted directly above the dynamo, and the whole set is arranged on a cast iron base. These sets are made in several sizes ranging in output from ¾ kilowatt to 1½ kilowatt.

There is again on view the single cylinder two-stroke oil engine, with a separate scavenging pump, to which we referred in connection with the last Fair

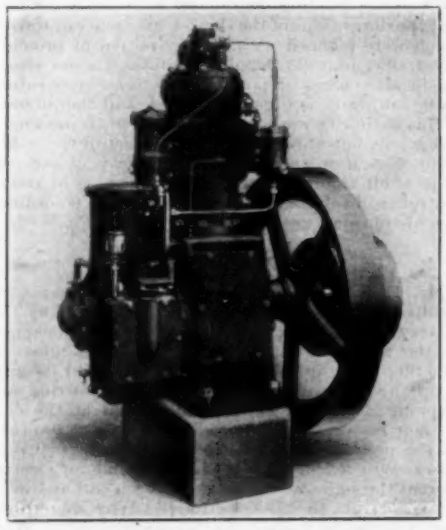


FIG. 8—14 B.H.P. CRUDE OIL ENGINE—CROSSLEY

at Castle Bromwich, and which was described at some length in THE ENGINEER of January 22nd last, but it stands out as being so distinct from other engines of its class that it is worthy of some further mention. A general impression of the appearance of this engine will be gathered from Fig. 8, from which it may be inferred that the crank shaft is extended on the side opposite to the fly-wheel, and is there provided with a crank for operating the scavenging pump. The result is that the main crank case is relieved from any air compressing work, and the lubrication of the bearings is thoroughly ensured, while there is no likelihood of loss of scavenging pressure through leakage along the journals.

In view of the fact that we described the oil engines made by the Blackstone Company, Ltd., of Stamford, in detail in our notice of the British Industries Fair of last year, it is hardly necessary to enlarge upon them on the present occasion, but it should be pointed out that the company is exhibiting an engine of 100 brake horse-power, together with a little set of 5 horse-power, and an air compressor with a cylinder 4½in. by 6in. The most noteworthy feature about these Blackstone engines is the method of injecting the fuel oil, which is effected by means of the release of a powerful coil spring. This spring is compressed by a crank on the lay shaft, against the resisting pressure of a pump plunger, which is intended to deliver the oil. The oil, however, cannot escape from the barrel as its outlet is closed by a needle valve, until the proper time for the injection of the charge of fuel arrives. The needle valve is then positively opened, and the whole of the force of the spring is instantly available to shoot the oil forward through the spraying device.

THE Indian Government has approved of the plans and estimates relating to the development of the hydro-electric power of the Pykara Falls in the Nilgiris District, and the work will be put in hand ere long.

Road Transport and Its Possible Developments.

THE annual joint meeting of the Institution of Civil Engineers (Birmingham and District Association), the Institution of Mechanical Engineers (Midland Branch), and the Institution of Electrical Engineers (South Midland Centre) was held at the Council House Birmingham, on Friday, February 12th, when consideration was given to the subject of "Road Transport and its Possible Developments." The principal speakers were:—Sir John Thornycroft, of the Institution of Mechanical Engineers; Major F. C. Cook, D.S.O., M.C., Ministry of Transport, Midland Section, Institution of Civil Engineers; and Mr. C. Owen Silvers, general manager and engineer of Wolverhampton Corporation tramways and motor omnibuses, Institution of Electrical Engineers. In the absence of Lord Montagu, Dr. F. W. Lanchester presided.

ABSTRACT OF PAPER BY SIR JOHN THORNYCROFT.

Recent developments which have taken place in vehicle construction have, I think, shown that designers have proved themselves capable of producing vehicles adapted for service, not only on good roads, but also over countries where only trackways exist. It is evident that the railways are beginning to fear competition and are getting perhaps a little jealous. Engineers will not dispute that there is certain work which the railway companies can legitimately do, which road transport cannot economically compete with, but this should not prevent our considering how far it is more economical to do other work, and the mere fact that a large amount of money has been invested in railway companies should not bar developments of road transport.

Legislation has undoubtedly had a great influence on the type of car produced in this country, and the War Office subsidy schemes have also determined to a great extent the types of goods-carrying vehicles. The size of vehicle which was selected for the subsidy type prior to the war—of a nominal capacity of 3 tons, but it would really take a good deal more—was made in such very large numbers during the war period and such a large proportion of them have since been brought into commercial use in the country, that they have necessarily tended to set a standard of capacity. At the end of the war there were about 40,000 to be disposed of and there are still some left. There is no doubt that about a 4-ton useful load is quite a good one for a great many trades, and in spite of the large number of second-hand vehicles which are being used, builders are still getting orders for considerable quantities of new ones of the same capacity. The fact that there are many thousands of ex-War Office vehicles which have now been at work for nine or ten years fitted with their original worms and worm wheels, is a pretty good proof that, when properly designed, they are an excellent means of transmitting the drive.

There are, of course, a great many vehicles suitable for greater and less loads than the 3-ton type in general use, besides light delivery vans and, during the last couple of years, the new War Office subsidy scheme for 30-cwt. vehicles has tended to make a pneumatic-tired vehicle, capable of carrying a net load of 30 cwt. at a high speed, a very favourite one.

It is, of course, advantageous to keep the tare of a vehicle as low as possible, provided lasting qualities are not sacrificed. By strictly limiting the weight, the War Office has had the effect of making builders improve their designs and has forced them to use the highest grade steels and materials generally. There is no doubt that the automobile industry has had a marked influence in the production of the steel which is obtainable to-day, and which permits of much greater stresses than was permissible when road vehicles were in their infancy twenty years ago. Then a stress in an axle or other part subject to reversal of strain was limited to about 3½ tons per square inch. To-day it may be safely doubled.

From an engineering point of view, there is no reason why vehicles fitted with pneumatic tires should not run at quite high speeds, and, with adequate braking power, 30 miles an hour is not unreasonable for a 30-cwt. load. For the heavier type of vehicle on solid tires, 20 miles an hour is not unreasonable when the tires are in good condition and the vehicle is well sprung.

For high speeds, pneumatic tires and very good spring mounting are, of course, essential. Some makers are adopting something rather like a bogey for their driving wheels. This, of course, has the merit that when going over uneven ground the vertical motion of the body is greatly reduced, but, for really good roads, it is a question how far the extra complication is necessary. American builders of this type of vehicle told me that the American public believe that a railway coach should ride on a bogey, and they consider the same argument applies to a road vehicle, and, if the American public got this into their head, they would not ride over a single axle and builders would be forced to adopt it, but I think it is doubtful if the British public would take quite the same view. There is no doubt that, for certain purposes, what is known as the rigid six-wheel type of vehicle has great advantages, and it has been proved that the reduction in the load on the wheels would enable it to compete with the Kegress or other track type in places where roads, in the true sense, do not really exist. You have no doubt heard that a vehicle of this type has made the journey from one end of Africa to the other, and for undeveloped countries there seems little doubt that the arrangement has a very considerable future.

From the point of view of the builder of the vehicles or those who run them in this country, the adding of an axle may seem an undesirable complication. Roadmakers may, however, take a different view, and it is interesting to consider the effect it has on axle loads. If we take an average twenty-eight-seated omnibus designed to comply with the proposed Ministry of Transport regulations as regards overall dimensions and overhang of body, the load on the front axle will be about 40 cwt., and the rear 80 cwt., and if we assume the vehicle fitted with two rear axles and the same mean wheel base, the load on the three axles will be approximately equal, namely, 40 cwt. on each, but an axle load of 80 cwt. does not seem enough to warrant the complication necessary to secure a reduction. A double-deck omnibus with a correspondingly greater load might be more suitable for a six-wheel arrangement, but as a rule double-deck vehicles are only used in large cities where the roads are constructed with a view to taking heavy axle weights. The Ministry of Transport regulations as regards overall length are not yet law, and it is possible that if the advantages of the rigid type six-wheeler had been considered, a greater overall length would have been permitted for them.

In considering the economics of transport by road, one must obviously take into account both the cost of the transport services, made up of the running costs of the vehicle, depreciation, &c., and also the costs connected with the roads on which they run, but I do not think anyone has as yet discovered a method of correctly applying the road costs, and the most we can do at the present time is to arrive at some general conclusions.

There is one thing about the goods-carrying vehicle which is greatly in its favour. The designer is, in a measure, responsible for the road damage, inasmuch as the gross moving load depends on the weight of the vehicle he provides. He has been able to produce machines which on the average carry a load about equivalent to their own tare weight. Taking the case of the heaviest vehicle which can be run legally under the present regulations, there are examples of a 10¼-ton load being carried on an articulated six-wheeler with a tare weight of only 8¼ tons, so the ratio of tare to gross weight becomes 0·45. If we take an average 5-ton lorry, it will be found that the tare weight is about 5 tons, giving a ratio of 0·5. The 30-cwt. War Office subsidy vehicle weighs 43 cwt., with a 10-cwt. body allowance, and so the ratio in its case is 0·59. In the case of most city roads, there is ample strength to take the heavier existing axle loads, and that it is not worth while to multiply axles on the vehicles using them.

I have already mentioned the greatly improved material which makers have available at the present day, but I do not think, outside the circle of those who are intimately acquainted with motor vehicle construction, that it is known that heat-treated alloy steels are being used for shafts and other parts that have an ultimate strength of 100 tons per square inch and a yield point of 90, and that gear wheels made of what is known as direct-hardened nickel chrome steel have an ultimate strength of as much as 110 tons and a yield point of 95. For valves and certain other parts which are subject to corrosion, such as pump spindles, rustless or stainless steels are being used with very satisfactory results. All sorts of alloy steels have been used for the springs, but silico-manganese seems now to be generally recognised as the best. In the motors themselves, the tendency has been greatly to stiffen up crank shafts to avoid periodic vibration and to standardise on side-by-side valves. Provided an equally good consumption and performance can be obtained, the simplest arrangement must be the best, and there seems little doubt that this is obtained by the side-by-side valve and detachable cylinder head.

With a view to reducing the stresses in the moving parts, and also to enable higher compressions to be used without pre-ignition, many firms have been trying aluminium pistons and some duralumin connecting-rods. It may not be known generally that aluminium is being used instead of cast steel by some people for road wheels of quite heavy vehicles, and that it is possible now to get a material, viz., magnesium, which is quite as strong, two-thirds the weight of aluminium, and no more costly, for the casting. It has been known for some time that magnesium castings can be made, but it is only quite recently that any firm has been ready to take castings for such things as engine bed-plates and road wheels in this material.

ABSTRACT OF PAPER BY MAJOR F. C. COOK.

The development of road transport is obviously dependent upon the road, which is, in fact, the permanent way of all road vehicles, and it is to the road in its relation to the necessities and economies of road transport that I propose to address myself.

To-day in England and Wales there are 153,000 miles of roads, administered by no less than 1885

highway authorities. True, the main trunk roads are in the hands of the County Councils, but these account for less than 20 per cent. of the total, and the remainder are administered by various authorities, ranging from County Boroughs to Rural District Councils.

Of the 153,000 miles, 20 per cent., or approximately 30,500 miles, are classified, and, as such, receive grants from the Ministry of Transport, representing 50 or 25 per cent. of the approved expenditure, according as they are placed in Class I. or Class II. Apart from the constitution of the Ministry of Transport, the most recent change affecting road development has been the setting up of regional committees under the Town Planning Acts. The functions of the regional committee are purely advisory, and the financial responsibility for road development remains, as a general rule, the burden of the highway authority administering the area concerned.

The total expenditure of local authorities on the maintenance, improvement and cleansing of roads and bridges in England and Wales during the year 1922–23 was £40,246,000, equal to £1 1s. 1d. per head of the population. This sum includes the grants from the Road Fund, of which the revenue for the current year is estimated at 17½ million pounds. The contribution from the Road Fund towards the upkeep of classified roads is approximately 11 millions, the balance being devoted to other necessary improvement works. Unlike the railway—considering both as the permanent way—every penny spent on roads is provided by taxation—say, one-third by motorists of all classes and two-thirds by the local ratepayer.

The question of the width of the roads is one of great importance. A unit of 10ft. for each stream of traffic is generally accepted; but there is much difference of opinion as to the greatest number of traffic lines for which provision should be made. We must picture our roads, not as carrying the traffic of to-day, but under the conditions for which they are, in fact, designed, and I fancy experience will show that it is possible to have a carriageway too wide, so that the frequent hold up of traffic on the main thoroughfares, in order to permit crossing from branch roads, will seriously detract from the usefulness of the extra width, whilst the passage of pedestrians from one side of the road to the other will become a somewhat hazardous adventure. There is much to say in favour of the double road—for up and down traffic respectively—of which we have excellent examples in Birmingham, in the Bristol-road and elsewhere.

I will say very little about construction, since to do so would involve a discussion of the comparative merits and uses of various materials, from granite setts to water-bound macadam. There is, in fact, no engineering difficulty in constructing a road strong enough to bear the heaviest unit load, in making a track capable of enabling a light car to negotiate any curve at any speed, or in providing a surface which will enable a horse to pull a heavy load with certainty of good foothold and a minimum of tractive effort. The difficulty arises in devising a means of providing for all these desiderata at one and the same time and at a cost which will keep the financial burden within reasonable limits.

The economic value of a surfacing material depends upon its cost per annum for capital and maintenance charges combined. It must be chosen with due regard to the traffic likely to come upon it, and duration is not the sole consideration, for it is as uneconomical to use a material unnecessarily expensive in first cost as one which gives an insufficient life, or upon which maintenance charges are unduly heavy.

Economically considered the aims of the road-maker and the road user are the same, viz., the reduction in cost of maintenance and the increase in carrying capacity of both the road and the vehicle. The condition of the track has a distinct relation to the running cost of the vehicle, whilst the type of vehicle reacts definitely upon the cost of maintenance of the track, and it is worth considering what is the practical effect of the one upon the other.

The chief destructive effect of the vehicle upon the road, especially on water-bound roads, is caused by the driving wheels and is a shearing force developed between the wheel and the road surface, increasing with weight and speed and accentuated when the car is travelling on a curve. In the case of comparatively slow-moving vehicles carrying heavy loads, an additional important factor is that of impact, and this is complicated by considerations of the speed and springing of the vehicle, the method of braking and the nature of the tire with which it is equipped. Tests have shown that the impact due to a vehicle equipped with pneumatic tires running at a speed of 15 miles per hour is less than that of the same vehicle with solid tires running at a speed of 5 miles per hour, and that the ratio of damage done by different types of tires can be taken as pneumatic 1, new solid rubber 4, steel 24. The benefit of the solid tire diminishes rapidly as it loses resiliency, owing to wear, whilst it may be accepted that the speed of a vehicle equipped with pneumatic tires concerns the public safety more than road damage.

It seems doubtful if any sensible reduction can be looked for in the unsprung weight. So far as the motor lorry is concerned, the usual type of spring is largely inefficient until the load of the vehicle approaches its maximum, and indeed there is some truth in the observation that a heavy lorry, loaded, does less damage than the same lorry empty, running at two or three times the speed.

There are regulations already in existence limiting the axle weight and so on; but it is a matter of argument as to what extent such restrictions are in the public interest. There is one type of locomotive—that with steel strake tires—which the road engineer would like to see eliminated. Happily, negotiations are now in progress with the Traction Engine Owners' Association by which it is hoped that all such vehicles will be provided with rubber tires at no distant date.

We have met to-night to discuss as engineers the possibilities of development of one means only of transport—the road—but as citizens let us guard against the tendency so to narrow our horizon as to fail to appreciate the problem as a whole. The road and the rail, the river and the canal, each has its part to play in national development, and in matters of transportation each should be used for the purpose for which it is most suitable. One should be the feeder of the other, making a system both comprehensive and complementary, and a wise administration, whether national or local, will have regard to such considerations and will shape its policy to that end.

Abstract of Paper by Mr. C. Owen Silvers.

I propose to deal briefly with the electric tramway, trolley vehicle, battery vehicle and the petrol vehicle, and to add a few remarks on the road transport problem generally.

Twenty years ago the electric tramway was supreme in catering for passenger transport, and for moving large bodies of people safely, swiftly, comfortably and economically this method of transport has not been surpassed. In large cities and industrial areas it would be impossible to substitute motor omnibuses or trolley vehicles, and still carry passengers at the low fares now charged on the tramcars.

The question of cost of transport is dependent on the density of traffic which has to be catered for, and a fair method of cost comparison is based on the average seating capacity of the vehicles. Below I give the total cost per 100 seat miles for tramways, trolley vehicles and motor omnibuses on the Wolverhampton system during 1924–25, and the tramway costs and motor omnibus costs for the same period in the city of Edinburgh:—Total cost per 100 seat miles: Wolverhampton tramways, 39·56d.; Edinburgh tramways, 30·699d.; Wolverhampton motor omnibuses, 44·56d.; Edinburgh motor omnibuses, 55·247d.; Wolverhampton trolley vehicles, 37·34d.

It will be noticed that the tramway in its proper sphere in the city of Edinburgh is cheaper than the other forms of transport. Tramways suffer under certain statutory disabilities, such as the assessment of rates for the track, the obligation of carrying privileged people at reduced fares, and in many ways they have not equal opportunity with motor omnibus competition; but in spite of this the tramcar is still the most efficient and satisfactory instrument of passenger transport where traffic is dense.

One of the most important electrical developments in road transport during the last two or three years has been the growing popularity of the trolley vehicle. Where the traffic is less dense and where in earlier days a single track with passing places would have been laid, no engineer to-day would think of running a tramway. Roads to-day should be built to carry the ordinary mechanical traction of the district, and the modern trolley vehicle comes within this category, and there are innumerable instances where the electrically operated mobile trolley vehicle can be applied more successfully than either the tramcar or the motor omnibus. It is generally admitted that where the roads are good there is no smoother, more comfortable, more noiseless method of conveyance with a complete absence of engine vibration and exhaust fumes. The useful field of operation for this type of vehicle is in a moderate density of traffic with a comparatively big number of stops per mile. Out of my thirty-two vehicles, seven have been in operation two and a-third years, and have completed an average mileage of between seventy and eighty thousand each, with no mechanical or electrical trouble beyond the tuning up of the controllers. The point in design which I think might be developed and improved is the method of collecting current from the overhead wires, which although quite workable, leaves something to be desired as a really sound engineering job. The motors are exceedingly light, weighing only 23 lb. per horse-power, and any great reduction in weight cannot be expected. There is no doubt at all that to get the greatest benefit from this vehicle and from the motor omnibus, the suggested limit of weight by law to 9 tons loaded and 26ft. in length must be increased.

Fifteen or sixteen authorities are now running trolley vehicles in this country, and many others have trolley vehicle routes under construction or are considering adopting this form of traction. Darlington and Ipswich, amongst others, are scrapping the whole of their tramway tracks and substituting trolley vehicles. Nottingham has a route under construction. This method of utilising electric power is also going ahead in America and the Colonies.

If we now consider the position of the battery vehicle in modern transport, superficially it appears that this type of traction is not holding its own. The more extensive use of these vehicles in the past has, in my opinion, been prevented by several reasons:—

(1) The lack of organisation by the supply authorities for the provision of cheap current; suitable, plentiful charge stations, and means of battery exchange. I am told there are only 300 public charging stations in the country, and if we visualise this, and consider the number of kerbside petrol pumps one sees in a small town, it will be realised what a great campaign is needed for the proper supply of electrical energy. Undoubtedly the proposed national scheme would tend to improve the conditions under this head.

(2) The manufacturers have taken a narrow view of business and based their prices on too small an output, making the capital cost high when compared with a petrol vehicle.

(3) The necessity for replacing all horse-drawn traffic with mechanical transport in the general interest of the community for the elimination of congestion has not been realised.

The organisation of super-power schemes shows that the electricity authorities are capable of some vision, and I have no doubt that the next few years will see a great development in the use of battery vehicles in our streets and roads. It is calculated that 150 electric vehicles require 1,000,000 "off peak" units every year.

There is little need for me to say very much regarding the petrol vehicle, but I would like to emphasise that the efficiency and reliability of the petrol vehicle is largely due to the electrical engineer in perfecting the magneto ignition and the electric lighting and starting systems employed. I should also mention that for passenger traffic the petrol-electric drive has proved itself the most satisfactory method of power transmission in many transport undertakings, and this type of drive is particularly popular in the Midlands.

Speaking on road transport matters in general, the one outstanding consideration is the hard fact that the dimensions of the thoroughfares in our towns, which were planned without any notion of present-day traffic, imposes definite limitations upon street use in all centres of population. Some over-riding traffic authority is urgently needed, and the interest of this authority must not be restricted to passenger and goods, but must include an interest in the roads themselves if we are to have efficiency of service. In fact, all arguments around the question of traffic control tend towards the necessity for the co-ordination of transport generally.

Discussion.

Mr. F. J. Moffett commented on the wonderful results that can be and were being obtained by the battery vehicle. The battery vehicle was handicapped by the weight of the storage battery, but notwithstanding that drawback it was able to hold its own in urban work, where there was frequent starting and stopping. Electrical engineers were not at the end of their resources, and hoped to be able to improve on the present storage battery. Most physical processes were reversible. When they sent an electric current through water, they got oxygen and hydrogen given off from the two electrodes. Why should not that process be capable of being reversed? Why should it not be possible to combine oxygen and hydrogen in such a way as to get electric current generated? If that could be carried out the weight of the electric storage battery would be very considerably reduced.

Major Brooke said Sir John Thornycroft told them they could look forward to a great increase in long-distance travelling by motor omnibus; but he did not say the same thing about the carriage of goods. He was afraid there was feeling among automobile engineers that the carriage of goods by road would not extend in the way it might have been hoped, and that when the railway companies really got down to business they would take the long-distance goods traffic. Civil and mechanical engineers, he thought, would agree that that was what should be in the case of long-distance traffic.

Mr. Malins said no mention had been made in the course of the discussion of the hindrances to other users of the roads. He suggested that that was a serious point. With regard to traffic regulations in town and city it often happened that laden lorries were held up and had to lose a lot of time waiting—for instance, for tramcars—the roads being too narrow to accommodate a double line of traffic. That was one aspect of the tramway problem which should receive attention. Then the weight of the tramcar was something like 15 tons. The petrol-driven vehicle was proportionately far less weighty. Generally speaking, the tramcar was the most ponderous vehicle on the road for passenger traffic.

Major Aveling suggested that the whole kernel of the problem of motor traffic was the relation of the total travelling load to the carrying load, and the need of increasing the useful or carrying load. It would be useful to know that ratio in the electric vehicles. He was interested to hear Major Cook say that the cost of roads was 40 million odd. It was important to realise that the whole of the railways did not spend more than 25 millions on their permanent ways. Therefore, the suggestion was that the 40 millions were rather mis-spent money, or, if not mis-spent, at least ill-used. The permanent way

of the railways was only allowed to bear a certain weight. If an ounce more than was fixed by the permanent way engineer was added, it had to be taken off, but he could run a 100-ton vehicle every day on the roads and no person or local authority would stop him.

Mr. A. Reeve observed that the wish was father to the thought. He thought permanent tramways were not likely to be developed extensively in the future. During last year in America no less than thirteen towns abandoned their electric tramways in favour of motor omnibus services.

Mr. Shine said the representative of the electrical profession had enormous courage in talking of the battery vehicle. He did not think the argument raised concerning the battery vehicle could be sustained. It was interesting to note who were the people who bought battery vehicles. It was usually those who had the votes behind them. He believed it was usually corporations, and whether the job made a profit or loss, they did not, as a rule, worry very much about it. The petrol-electric had inherent defects, one, of course, being bad acceleration. If relatively high speeds were wanted, a very big engine was necessary. With regard to Sir John Thornycroft's remark about brakes for heavy vehicles, he certainly thought that the four-wheel brake would be indispensable for public service vehicles. He was glad to hear Sir John champion a brake of that kind. He had a great belief in the hydraulic brake, because the driver had his foot on it and was able to feel the pressure which was being applied.

Mr. Bevan said it appeared to him that the question of road surfaces was most important, and that we were only on the eve of deciding what was the most effective surface. The camber that had to be put on the roads to-day often caused a tilting of the traffic. As to concrete roads, it frequently happened that in cities there were many kinds of surface pipes under the roads. In new roads it was most desirable, when at all practicable, that such pipes should be laid under the land on either side of the carriageway, and that course was, he added, being followed on the Wolverhampton–Birmingham road now in course of construction.

Mr. Joseph expressed the view that one of the chief reasons why the electric vehicle had not forged ahead was that it had been developed on entirely wrong lines. It should have developed on standard lines—voltages should have been standardised and batteries made interchangeable. If cars were designed to utilise various units, he visualised the time when charged batteries might be bought at wayside shops, just as a can of petrol was to-day. He believed such a development would make the electric vehicle a possibility for urban traffic.

Dr. Lanchester, terminating the discussion, observed that the question that occurred in the early development of the commercial vehicle was softness of the chassis; as far as he could remember the vehicle that conquered the London streets was believed to be distinctly on the principle of being limp. That chassis was not safe enough, however, if taken over really bad roads. He was sure many lorries that were working successfully to-day would not have stood up on the roads they started with. The roads and the vehicles developed together. On the subject of stresses in axles, Sir John referred to 3½-ton stresses having been doubled, but he believed instances could be quoted where the shear stress had been increased nearly twenty times compared with that of twenty years ago. The principal factor in the increase of shear stress in axles was the pneumatic tire. It was such tires that had saved the situation quite as much as the new steel. As to regulations, it would seem that they should be like tires, as flexible as possible. On the question of road costs, he thought many persons had forgotten the historical aspect of the matter. The old turnpike roads were good; and the question of whether they paid was settled by ordinary commercial considerations—there was the payment of toll by the user, and certain people got to know whether a type of road would pay or not. Then when the turnpike roads were freed of toll, the question was asked, "Does it pay to put a road there or not?" That was a distinct disadvantage arising from that change. There seemed to be a loss of the sense of economies on the road question. It was necessary that a broad view should be taken. Because a road passed through a particular district, that district must not say we get no benefit out of it. Everybody was getting a benefit from it, and it should only be a matter of how the money was collected. There should be a basis that was reasonable and fair. It might be done on rateable value or something of that kind; but it was not a question for the consideration of individual areas. Again, it was most important to insist on slow-moving vehicles keeping on their own side. On the question as to the effect upon tires, there should be given, he thought, some encouragement, in the way of rebate, to users of tires on heavy vehicles. They certainly represented less wear and tear on the roads.

THE railwaymen, fired by the success of their tableaux at the Belle Vue, Manchester, railway centenary celebrations last September, are making arrangements to film many of the activities connected with a railway.

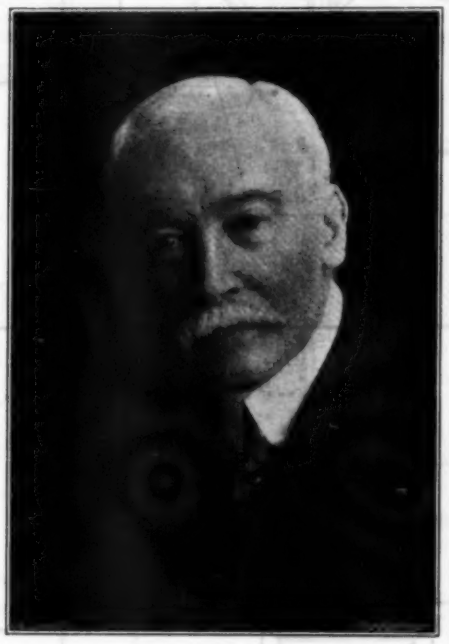
Obituary.

SIR GEORGE HOLMES.

THE announcement of the death of Sir George Holmes at the age of seventy-seven, which took place in London on Saturday, February 13th, following an operation, will be the cause of widespread regret among his many friends, particularly the older naval architects and marine engineers with whom he was for many years so closely associated.

George Charles Vincent Holmes was born in 1848, and was the third son of Mr. Robert Holmes, of Moycashel, Co. Westmeath. He received his education at Downham College, Cambridge, and in 1871 was awarded a Whitworth Engineering Scholarship. Following his apprenticeship at the Crewe locomotive works of the London and North-Western Railway Company, he became associated with his uncle, John Scott Russell, in the work of building the large iron rotunda for the Vienna International Exhibition of 1873. His appointment as resident engineer for this work gave him wide opportunities for furthering his engineering training, and at the same time it enabled him to acquire a knowledge of foreign languages, for which he had a natural aptitude, which was of considerable use in his later career. On the completion of the exhibition work he was made a member of the International Jury of the Exhibition and served on the prime movers section, on which he reported for the Royal British Commission.

In 1878 he was chosen from several candidates to fill the office of secretary to the Institution of Naval



SIR GEORGE HOLMES

Architects, a position which had been previously held by Mr.—later Sir—Edward Reed. The Institution was at that time in the eighteenth year of existence, and among its leading members were John Scott Russell, Sir Nathaniel Barnaby, and Sir Edward Reed. George Holmes brought to his work a keenness and enthusiasm which gave a new impetus to the Institution, and for over twenty-two years he served it with conspicuous ability. Among the Presidents during his term of office were Lord Ravensworth, Lord Brassey and Lord Hopetoun. The "Transactions" of the Institution during these years are themselves a witness to Holmes' technical and literary abilities. Work which proved congenial and successful was the organisation of the meetings of the Institution which were held at various shipbuilding centres in the United Kingdom and abroad. Particular reference should be made to the very successful meetings of the Institution which were held in Paris in 1895 and in Hamburg and Berlin the following year. The German visit of 1896 had an important consequence, for in 1899 the Schiffbautechnischen Gesellschaft was formed in Berlin on lines similar to those of the Institution of Naval Architects. In 1897, the year following the Hamburg visit, the Council of the Institution decided, instead of holding an ordinary summer meeting, to convoke an International Congress of Naval Architects and Marine Engineers, to mark the sixtieth year of the reign of Queen Victoria. The Congress which was organised by George Holmes was a very successful one, and was attended by representatives of the Ministries of Marine of the chief naval Powers, and by representatives of kindred societies abroad.

On retiring from the Institution of Naval Architects Mr. Holmes was presented with a testimonial. In the same year, 1901, he was appointed Chairman of the Board of Public Works in Ireland. The recipient of several honours, he was five years later knighted K.C.V.O., and before he retired from his public work in Ireland he was made K.C.B. During recent years he lived in London. Apart from his association with the Institution of Naval Architects and the "Transactions" of that body, he published several books, including the "Text-book of the Steam Engine," "Marine Engines and Boilers" and "Ancient and Modern Ships," which are handbooks of the South Kensington Museum.

Sir George Holmes combined in a remarkable degree capability with personality. Possessed of an excellent presence, the gift of tongues, a knowledge of men of many nations as thorough as his knowledge of engineering, and an Irishman's power of ingratiating himself, he handled difficult affairs with consummate skill, and steered the Institution to which he devoted a great part of his life through its renaissance with a cleverness which commanded the respect of its members.

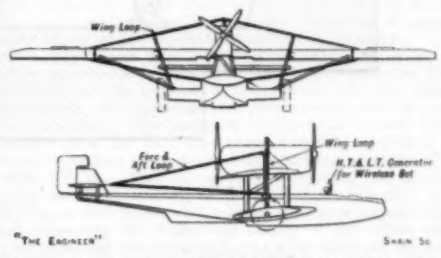
The Wireless Equipment of a Seaplane.

WIRELESS apparatus now forms an important part of the equipment of aircraft used for combatant services or for commercial purposes, and not the least of the many factors contributing to the successful Transatlantic flight of Commandante Franco was the use of the wireless apparatus installed on the Dornier seaplane, the Ne Plus Ultra.

The Dornier Wal seaplane is constructed of metal and was equipped with a Marconi standard type A.D. 6 telegraph-telephone set and a Marconi direction-finding set.

A special type of loop aerial was fitted on the machine, and the Marconi standard aircraft direction-finding receiver was altered to increase the working range of the equipment.

The fore and aft loops consist of two single-turn loops supported on struts and arranged symmetrically on each side of the hull, great care being taken to avoid any out-of-balance effects owing to the presence of large masses of metal. The two loops are connected in series, and the total area turns is approximately 250 square feet. In order to obtain equal reception with the wing coil, a single turn loop is mounted in the plane of the wing. The two sketches below show the positions of the two fore and



FLYING BOAT FITTED WITH WIRELESS EQUIPMENT

aft loops and the wing loop. The terminal ends of the loops are connected by a length of cable leading to the navigator's position near the pilot.

To increase the working range of the direction finder and to compensate for the smaller receptive power of the loops, it was found necessary to increase the overall magnification of the standard aircraft direction-finder receiver. This was accomplished by the use of a twelve-valve amplifier divided into two units, the first unit containing six stages of high-frequency amplification and a detector valve, and the second unit an oscillator valve, two stages of intermediate frequency magnification, a detector valve and a note-magnifying valve. The anode voltage for the receiver is supplied by a ninety-six-volt dry cell battery and the filaments are run off an accumulator battery. The radiogoniometer and high-frequency tuning unit are of the standard type supplied with aircraft equipments, and cover a wave range of 600 m. to 1000 m. The equipment was calibrated on wave lengths of 600 m. and 900 m., and the quadrantal error curves were well within the limits required for navigational purposes.

Reports from Captain Ruis de Alda, the navigator who took the direction-finding bearings during the flight, show that bearings were obtained at a distance of 700 kiloms. from Las Palmas, and such was the accuracy of the readings that the course was directed solely by the aid of the direction finder during this stage of the flight. When nearing Las Palmas visibility was very poor, but the signals from the shore stations enabled the navigator to maintain a direct course to his destination.

The standard type A.D. 6 telegraph-telephone set was used for the transmission and reception of ordinary service messages, the essential components of both transmitter and receiver being mounted in one unit. The transmitting system comprises an aerial tuning inductance, an oscillation valve, control valve, and a sub-control valve; whilst the receiving system comprises an aerial tuning inductance and a five-valve amplifying detector.

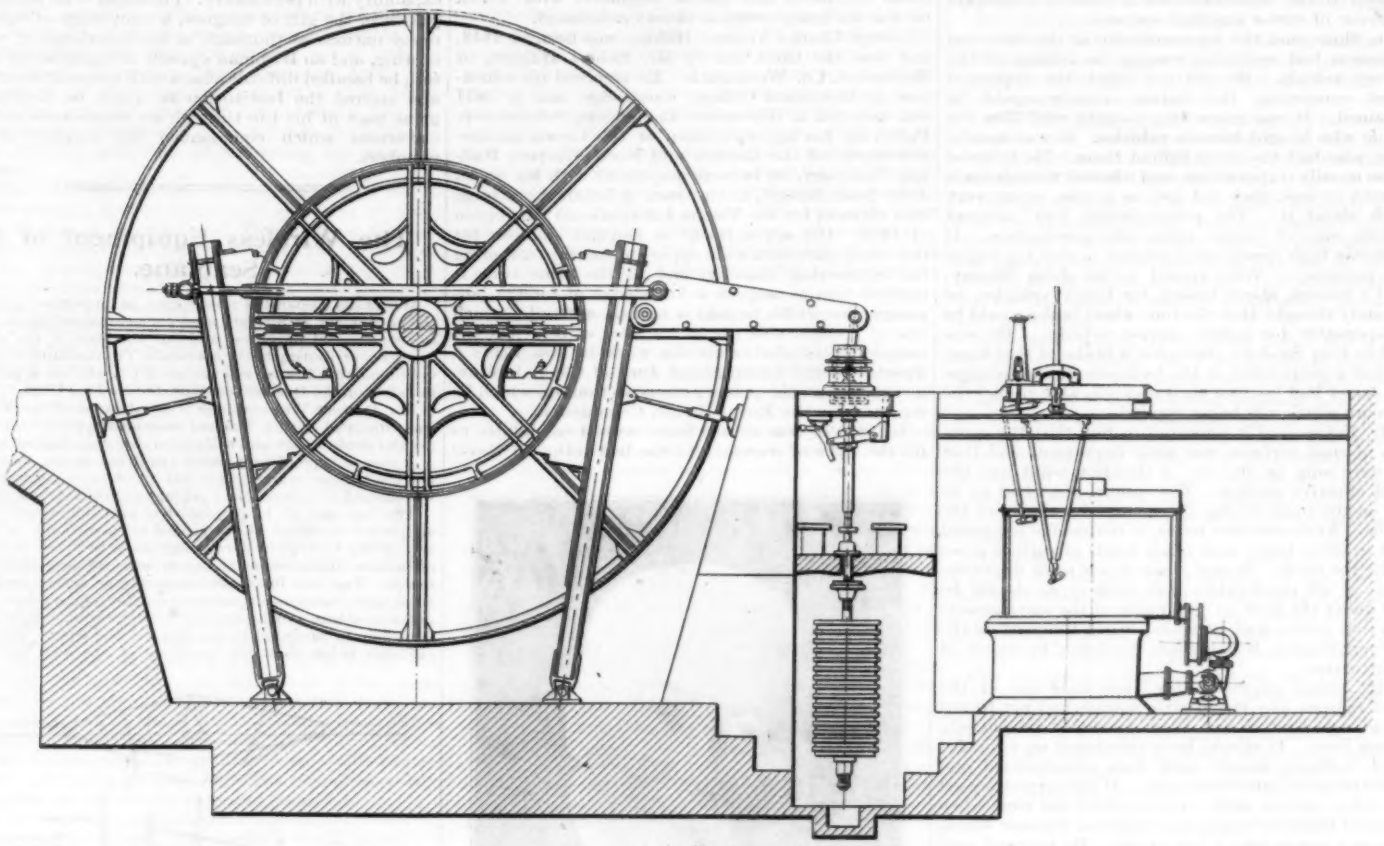
On the transmitter two Marconi standard type M.T. 3 F. and one M.T. 5 are used, the total filament current being 6.6 ampères at a pressure of 6 volts. For reception two type V. 24 and three type Q X valves are employed, with a total filament current of 3.75 ampères at a pressure of 5 volts. The wave range of the transmitter and receiver is variable between 400 m. and 1200 m. The system of remote control by means of Bowden cable enabled the operator to change over the send-receive switch or to effect small adjustments in the tuning of the circuits.

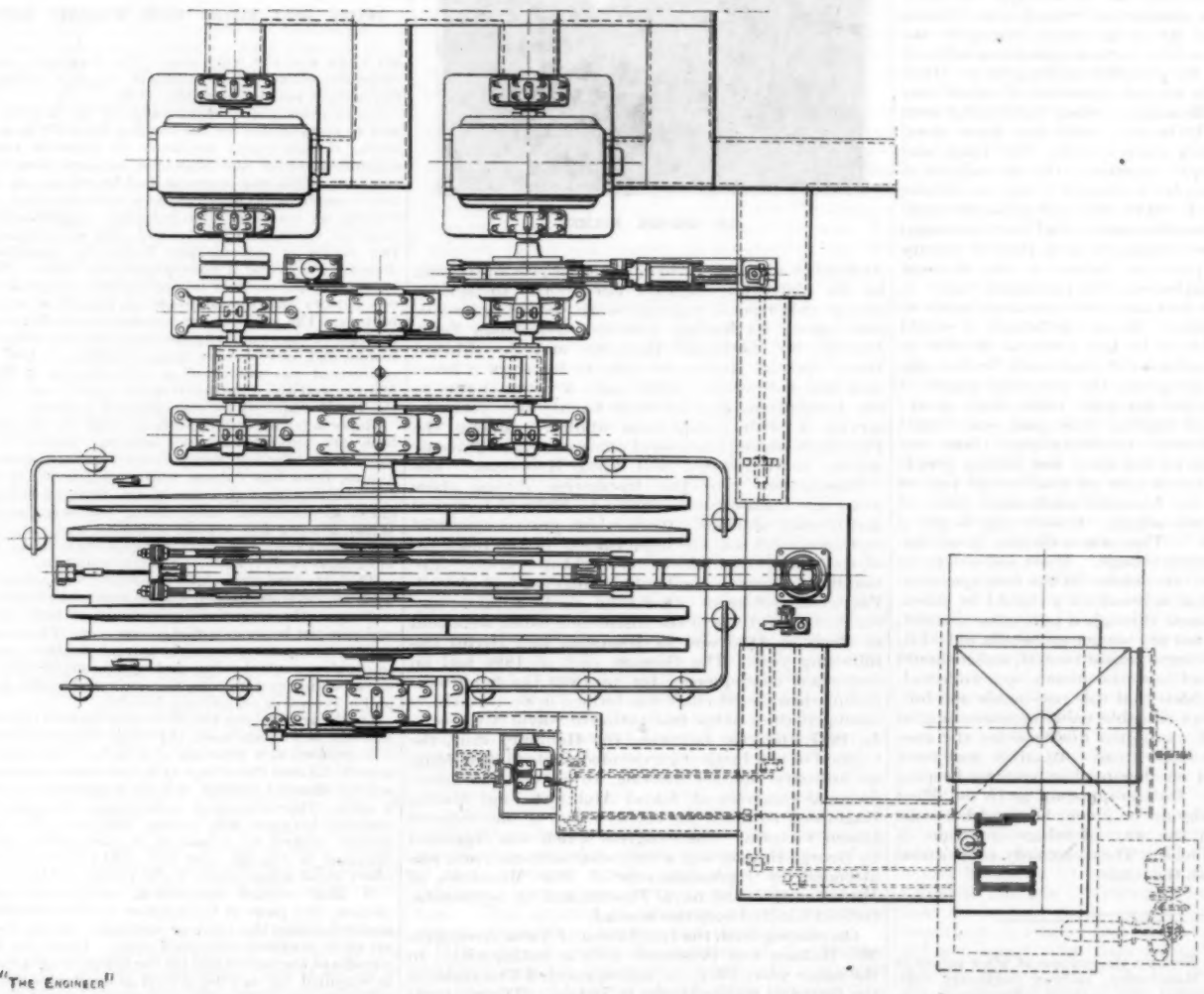
A dual control equipment, comprising two microphones, two pairs of headphones and two coupling units, enabled either the pilot or navigator to use the wireless set or to converse with each other. Power for the anode circuits of the valves and for the filament lighting batteries is supplied by a wind-driven generator developing 100 milliamps at 1500 volts and 6 ampères at 7 volts. A trailing aerial approximately 200ft. long is used for the set.

1150 H.P. ELECTRIC WINDING GEAR AT THE MONCEAU-FONTAINE COLLIERY, BELGIUM

LES ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, ENGINEERS

(For description see opposite page)





"THE ENGINEER" SWAIN SC.

Electric Winding Gear at the Monceau-Fontaine Colliery.

(By our Special Representative on the Continent).

THE great depth of the Belgian coalfield has necessitated the use of a large number of flat-rope winding gears, as in many cases the accommodation of the necessary amount of round rope on a drum of the ordinary type is practically impossible. With flat-rope winding gear, the rope takes the form of a comparatively thin woven band of steel wire, which is wound on itself, like tape on a bobbin, as the cage is raised. There are, of course, decided constructional advantages in the system. The drum is simple and light, with none of the complications of the cylindro-conical drums with their large dimensions and heavy stresses. It is true that the flat rope is, as a rule, less durable than the round rope, but for shafts beyond a certain depth its use is almost compulsory.

Several flat-rope winding plants have recently been installed by the Société Anonyme des Ateliers de Construction de Charleroi in Belgium. One of these, now in service raising coal from the main shaft of the Piéton Pit of the Société des Charbonnages de Monceau-Fontaine, is illustrated in Fig. 1 and on page 210. Photographs of two very similar winding engines for other pits of the same company are reproduced on page 214. It was originally the intention of the colliery company to use round ropes on account of their greater durability, but considerations of the size of the drums necessary, and the impossibility of getting a good lead for the ropes in the limited space available caused the idea to be abandoned, and a flat rope system to be decided upon. The plant in question is designed for an ultimate working depth of 1300 m., or 4265ft. the present depth being 805 m. Each cage, which with its fittings weighs 4000 kg., will carry eight wagons. The weight of an empty wagon is 300 kg., and loaded it will contain 600 kg. of coal, or 950 kg. of rock. The cable, when new, was 200 mm. wide by 25 mm. thick, its thickness being reduced to 21 mm. in service. It is composed

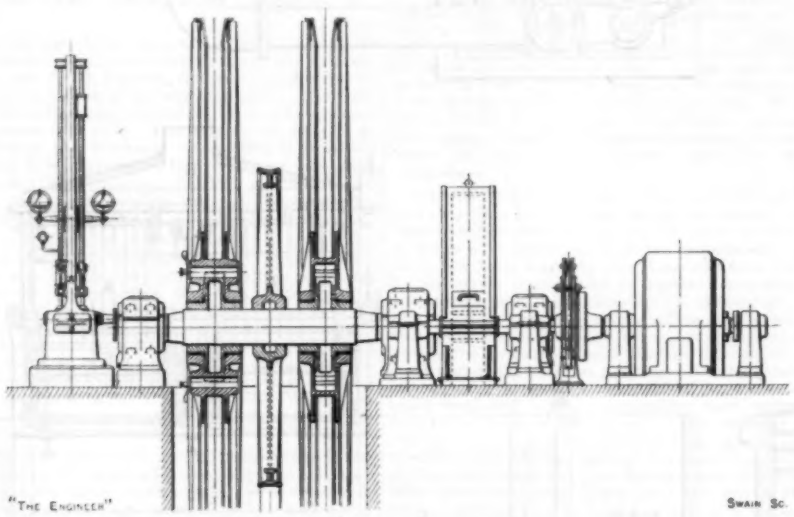


FIG. 1—VERTICAL SECTION THROUGH WINDING DRUMS

of ten hawsers each consisting of four strands of eleven wires of 1.8 mm. diameter each. It weighs 11.9 kg. per metre run, and has a breaking strength of 212,000 kg., giving a factor of safety of 9 when carrying its maximum load—at 805 m.—of 23,500 kg.

When winding from a depth of 805 m. the machine was required to be able to raise a useful load of 7600 kg. twenty-five times per hour. From a depth of 1000 m. it had to be able to raise a useful load of 6650 kg. twenty-three times per hour, while from the full depth of 1300 m. a useful load of 5700 kg. had to be raised twenty times per hour. The machine was also specified to be able to raise a load of 500 kg. from a depth of 1000 m. at a speed not exceeding 75 per cent. of the normal. A further condition had to be fulfilled, namely, that the winding engine should give a good commercial efficiency when working with cages of half the capacity above mentioned from a depth of 805 m.

To meet the conditions imposed, it was decided to drive the winding engine by two similar electric motors connected to the main winding shaft by double-helical speed-reduction gearing. The arrangement is illustrated in Fig. 1, and on page 210. The motors are placed side by side, their pinions engaging opposite sides of the main gear wheel, which is driven with a speed reduction of 9.85 to 1. The motors are of the induction type, taking three-phase current at 6300 volts and 50 cycles, and each is rated to develop 575 horse-power continuously. Their synchronous speed is 500 revolutions per minute. When it is required to operate the winding gear for a short time at the reduced capacity stipulated for in the specification, one motor can be disconnected by removing the bolts from the flexible coupling; for a longer period the pinion would, of course, be removed. It will be noted that the pedestals of the pinion shafts are mounted on continuous transverse sole-plates, so that the distance between the various shaft centres is rigidly maintained. The sole-plates are connected together by stiff cross beams, and a final grouting-in with concrete prevents any possibility of relative movement which would be so prejudical to the gear.

The drums are of the type usual in Belgium, consisting of cast iron centres carrying radial steel arms projecting from their side flanges. The arms are of built-up T section, and are connected at their outer ends to angle iron rims. Arms and rim serve merely as guides to ensure the even coiling of the rope on itself, and therefore have no stresses to withstand in normal working. The construction is, however, quite strong enough to deal with any want of alignment of the rope that is likely to occur. Each arm carries a facing of oak, where it may come into contact with the rope. Both of the drums are loose, in order that adjustment of the rope may be easily and quickly effected. They are mounted on hubs keyed to the shaft and each can be instantly locked to its hub by means of a simple device patented by the A.C.E.C. The principle will be clear by reference to Fig. 2. The piece A is a large cylindrical bolt carried in the loose part B of the drum, and capable of being easily rotated by means of a handle with gearing or otherwise. Round the circumference of the fixed hub C are semi-cylindrical pockets with which the lower half of the bolt engages, thus locking the drum and hub together. Part of the bolt is cut away, so that when it is turned to a certain position the drum can rotate freely on the hub, and the adjustment of the cable can then be effected. The bolt is not subject to bending force when at work, but it transmits the load by its resistance to shearing over a large surface. A safety locking device E is provided to prevent the bolt turning when in use. By using two bolts and an uneven number of pockets, the drum may have twice as many fixed positions round the hub as there are pockets, and so on. Provision may thus be made for any degree of adjustment required.

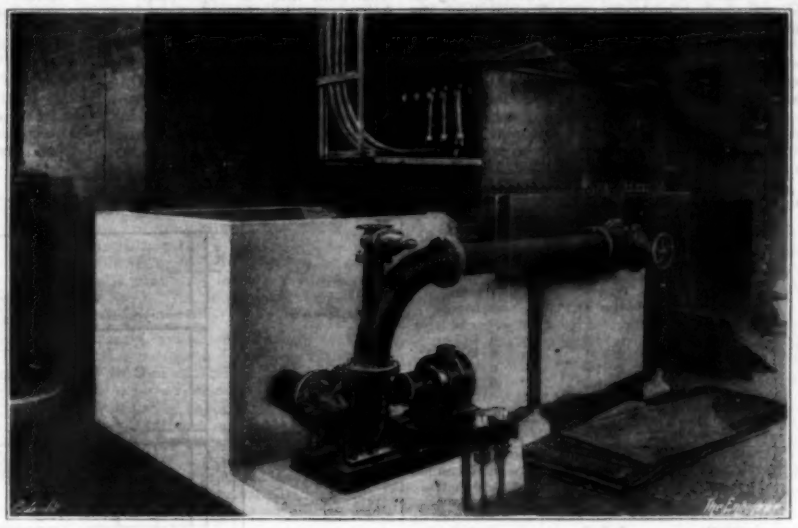


FIG. 3—DOUBLE WATER RHEOSTAT

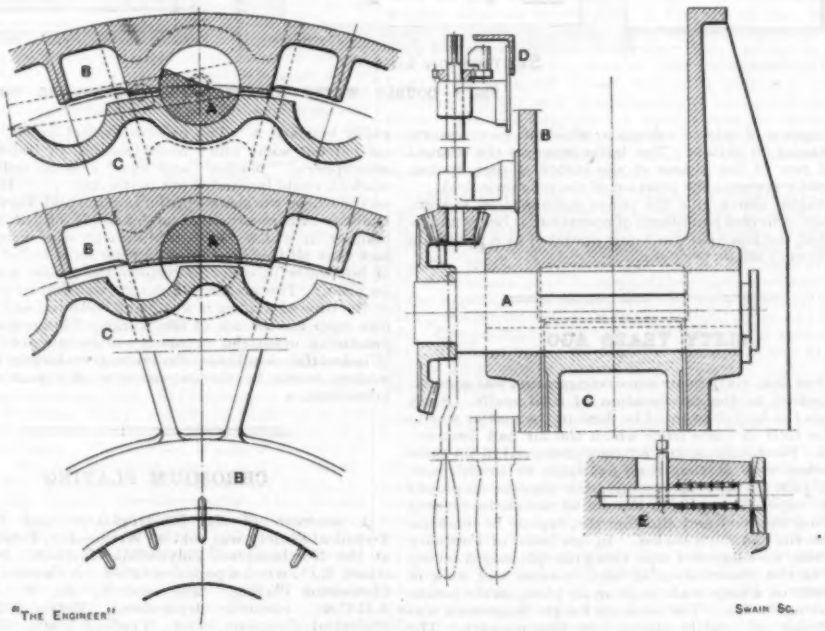


FIG. 2—CABLE ADJUSTING DEVICE

The brake pulley for the compressed air brake is of cast steel, mounted on the shaft between the winding drums. The rim is concave, and is acted upon by a pair of wooden brake shoes by the mechanism shown on page 210. This brake only comes into action either when put on by the safety apparatus or when the operator works the lever furnished for the purpose in accordance with the mining regulations. No apparatus for progressive action is therefore required. The ordinary mechanical service brake acts on one of the high-speed motor shafts, the rim of the flexible coupling being formed as a braking surface. This brake, like the other, is capable of stopping the machine under the most unfavourable conditions, namely, when running at full speed with maximum torque on one drum, and supposing the balancing action of the other drum to be suddenly removed owing to a breakage of the cable or some other cause.

The third of the operating levers is that for controlling the winding motors. These are started simultaneously by a double water-rheostat—Figs. 3 and 4. Each part of the rheostat has three fixed electrodes—A, Fig. 4—composed of numerous sheet-iron plates about 3 mm. thick. Each set of electrodes is, of course, connected to the slip rings of the rotor of the corresponding winding motor. The plates are specially shaped to give the required rate of change of resistance as the depth of immersion varies. The liquid used is a solution of carbonate of soda, which is delivered continuously by a 4.75 horse-power motor driven centrifugal pump into a tank B connected to the electrode chamber. This tank has a rectangular opening in one side, provided with a sluice valve E, through which the solution can escape into the ferro-concrete tank C below. The valve E is operated by the starting lever. Its position obviously determines the rate at which the

electrodes are immersed. The liquid passing into the bottom tank C, either by the valve E or the overflow from the tank B, is cooled by the coils D through which cold water is being continually pumped. There is a secondary sluice valve F, which is in series with the valve E. By its means the operator can, with the valve E open, keep the level of the liquid at its minimum, thus interposing the maximum resistance in the rotor circuit, and so winding at a slower speed, when men are in the cages. When coal is being raised, the valve F is placed in such a position that the motors start immediately the reversing switches are closed. It will be noted that the use of fixed electrodes and a constant delivery pump limits automatically the rate at which the resistance of the rotor circuit can be altered, no matter how rapidly the valves E and F may be moved. These valves are counterbalanced, so that the power required to operate them is negligible.

TABLE I.—*Both Motors Working.*

Depth of working, metres.	Useful load, kilos.	K.w.h. consumed per effective H.P.	K.w.h. consumed per 100 metric ton-metres.
800	7600	1·218	0·452
800	4800	1·320	0·489
1000	6650	1·213	0·450
1300	5700	1·464	0·542

TABLE II.—*One Motor Working.*

Depth of working, metres.	Useful load, kilos.	K.w.h. consumed per effective H.P.	K.w.h. consumed per 100 metric ton-metres.
800	3800	1·212	0·449
800	2400	1·620	0·600
1000	3800	1·235	0·457
1300	2850	1·330	0·492
250	2850	3·000	1·110
250	2400	3·400	1·260
180	2850	3·260	1·210
180	2400	3·700	1·370

To reverse the direction of rotation of the winding motors a three-pole change-over switch connected mechanically to the rheostat lever is provided. This switch controls the excitation of sets of solenoids, which in turn operate the reversing oil switch. The latter reverses the connections of two of the phases of the stator of each motor, and thereby reverses the rotation of the magnetic field.

The tables above give the power consumption guaranteed under different conditions of operation, it being understood that the machine was being operated at a minimum rate of twenty winds per hour.

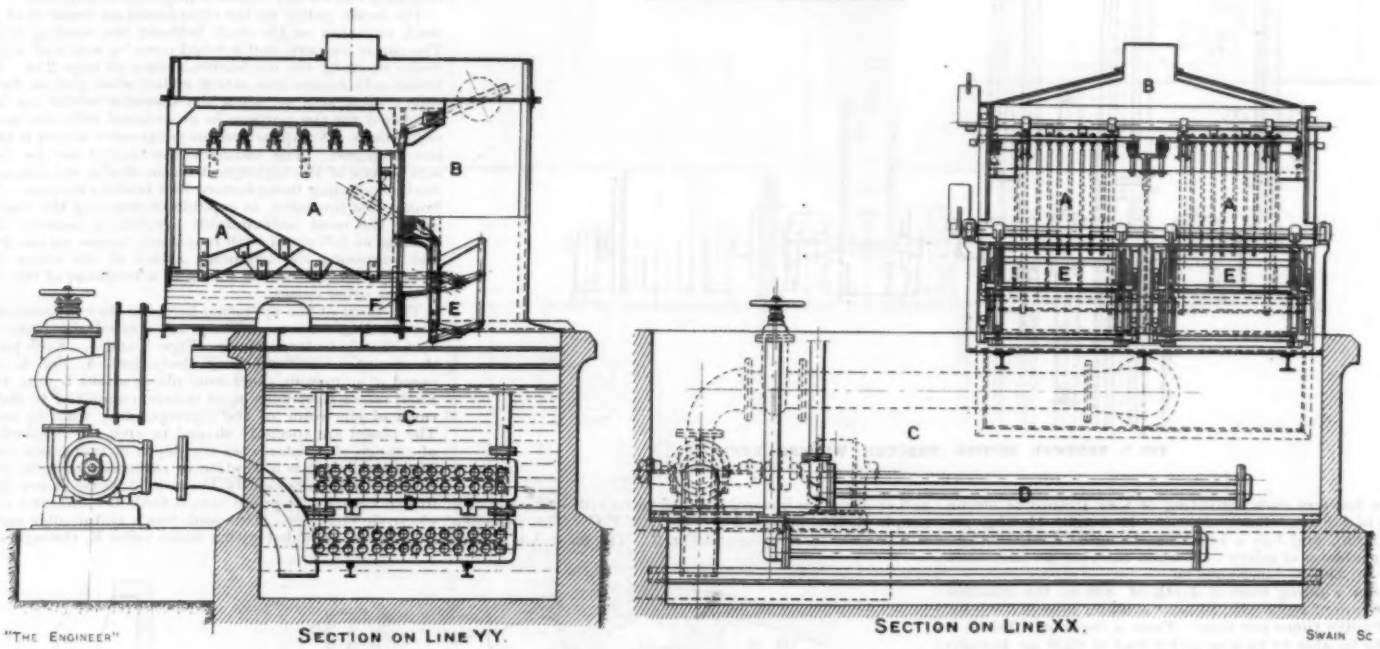


FIG. 4—DOUBLE WATER RHEOSTAT FOR CONTROLLING 2000 H.P. WINDING GEAR

SIXTY YEARS AGO.

IT is less than sixty years since refrigeration was successfully applied to the preservation of food stuffs. Sixty years ago the best that could be done in the matter was to pack the food in cases from which the air had been exhausted. Fresh salmon and lobsters preserved in tin cases in America were at that time available to British consumers, just as they are to-day, the process employed being to expel the air from the tin by the steam created on heating the food and allowing the vapour to condense after the tin had been sealed. In our issue of February 16th, 1866, we suggested that this principle might be extended to the preservation of beef, mutton and milk in plate tanks on a large scale, with an air pump as the means of removing the air. The occasion for the suggestion was an outbreak of "cattle plague" in this country. The immense losses which the farmers were suffering would, we feared, react on the agricultural implement industry. It seemed inevitable, we wrote, that the disease would only be stamped out by forbidding the transit of live cattle. The mechanical changes resulting from such a step ought, we suggested, to receive the attention of inventors. Some years had, however, yet to elapse before the progress of mechanical invention enabled food stuffs to be transported and preserved in bulk in the manner now familiar to us. In 1873 the first cargo of frozen meat was shipped from Australia, but the experiment was a failure. In 1875 frozen meat was brought over from America, and in 1880 success attended the Australian shipments. . . . From a paragraph in the same issue, it is to be inferred that we have now reached the jubilee of the blue print. In 1866 lithography was still employed for the purpose of taking a number of copies from a tracing. We had, however, so we recorded, recently seen some "beautiful specimens" of copies produced photographically by exposing to the sun the original tracing with a sheet of chemically prepared paper beneath it. The process, it was added, was being carried out some miles from London, in order to avoid atmospheric "blacks," and even a large order, we remarked, could be carried out in one day. . . . In an article on the Crewe workshops of the London and North-Western Railway, we recorded as an example of the systematic manner in which the establishment was managed, the fact that all the old engine brasses were boiled in a tank of hot water in order to recover the grease accumulated on them. The grease, we noted, was formerly sold, but at the time of writing it was being collected and converted into soap for the use of the works. This opportunity of practising industrial economy—although not, we hope, of industrial cleanliness—has now been largely lost to the modern works by the extensive employment of mineral lubricants.

CHROMIUM PLATING.

A MEETING of the Electroplaters' and Depositors' Technical Society was held on Wednesday, February 10th, at the Northampton Polytechnic Institute, St. John's-street, E.C., when a paper, entitled A General Survey of Chromium Plating," was read by Mr. E. A. Ollard, A.R.C.Sc., research department, Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester. The following passages are abstracted from the paper:—

Chromium has two properties which make it of interest to platers, namely, its hardness and resistance to corrosion. For this reason, a good many attempts have been made to find a satisfactory commercial plating process.

The processes employed may be divided into two main types, one using a solution of chromic chloride acidified with hydrochloric acid, and the other a solution of chromic acid with small additions of chromium salts. The first type does not appear to have given any satisfactory results in practice, and nearly all processes that have been worked on a commercial scale have been of the latter kind. In this type a high-current density has to be employed, and lead anodes are usually found preferable. Among the disadvantages are the fact that a large amount of gas is generated and has to be removed, owing to its virulent nature; the "throwing power" of the solution is very poor; and the temperature and other conditions have to be very carefully regulated. These difficulties, however, while they cannot at present be entirely overcome, can be greatly minimised in practice, and Dr. Liebreich's process is at present the most satisfactory. It seems more probable that the process is not a straightforward deposition one, but that chromium compounds are carried over and reduced on the face of the cathode by the hydrogen liberated in the process.

It has been found by test that chromium does not protect steel satisfactorily from corrosion unless a very thick and regular deposit is made. It is therefore considered advisable in plating iron and steel articles to give them first an underlying coating of copper or nickel.

A number of tests made in the chemical laboratory have substantiated this view, and shown that steel, plated first with nickel or copper and then with chromium, will give very satisfactory results under the usual tests. It was also found that chromium was not appreciably attacked by neutral chlorides, such as sea water, and that it would withstand the action of salt spray very much better than was expected.

Among its industrial applications, tests seem to indicate that chromium may be a valuable metal with which to coat metals for die casting and other purposes, and also for the coating of printing plates and machine parts that are subjected to heavy wear.

The cost of the process cannot at the present be estimated accurately; but, from the figures that have so far been obtained, it seems probable that the price, while more than nickel plating, will not be as high as has often been suggested.

THE Clan Line has appointed Mr. Alexander Cross, of Glasgow, as chief superintendent engineer of the line in London.

Railway Matters.

THE traffic receipts of the Mersey Railway Company last year were £1800 less than in 1924, but the expenditure was £4200 and the ratio of expenditure to receipts was 65.43 per cent., as compared with 66.78 per cent. The net result was that the deficit for the year was £406, as against £1007 in 1924.

IT is reported that the Northern Railway of France is about to improve its harbour at Dunkirk, so as to provide for a service from Tilbury. In this connection it should be remembered that the London, Midland and Scottish, in conjunction with the Port of London Authority, has powers to embark on a large scheme at Tilbury.

As related in our annual article on "Railways in 1925," the up widened line of the Metropolitan Railway is being equipped for electric traction between King's Cross and Moorgate. The down line between Moorgate and Farringdon-street is also being fitted, and when the work is completed electric trains will be able to use the down widened line up to and including Farringdon-street and pass thence to the main line at the cross-over junction west of that station.

AFTER a joint conference held last Tuesday at the Ministry of Labour, lasting all day, a settlement was reached in the railway power house dispute which had threatened to bring about a stoppage of the electric railways in London. Mr. Clower, one of the representatives of the railway companies, stated at the close of the conference: "The parties have come to an understanding, and the terms will be communicated to the unions in due course."

WHEN a signalman sees a vehicle on fire, the load on a wagon shifted, a passenger giving signals of alarm, an open carriage door, or any other untoward incident, he sends to the next box the stop-and-examine block signal. The man at the box in advance will then place his signals to "danger" and stop the train. That was done just beyond Rugby on the morning of the 11th inst., when it was found that a van carrying mails, newspapers, &c., was on fire.

OWING to the increasing importation of oil into Great Britain, and in order to develop its facilities on the Humber, the London and North-Eastern Railway has decided to construct a second oil jetty at Salt End, Hull. The jetty will support pipe lines and extend into the river approximately a quarter of a mile. The existing oil jetty is at present effecting the discharge of 340,000 tons of oil annually, and it is anticipated that with the new jetty the London and North-Eastern Railway will be able to handle more than double that quantity. The work is to be put in hand immediately.

RAILWAY companies, on gradients rising 1 in 260 or less, provide what are known as runaway catch points which would derail any vehicle that ran back. The points are kept open to derail by a spring, and close and reopen for each wheel. Such points were useful on the 11th inst., at Roe Green Junction on the Eccles–Bolton branch of the former London and North-Western. Eight wagons and a brake van ran away from Little Hulton Junction down a gradient varying from 1 in 40 to 1 in 90, but on the Bolton side of the junction with the Eccles–Tydesley–Wigan line there was a runaway catchpoint, which derailed the vehicles.

ADDRESSING the Railway Students' Association of the London School of Economics on the 11th inst., Lieut.-Colonel Francis, the stores superintendent of the Southern Railway, spoke of the large sums of money tied up in material and stores, all of which were costing the companies a considerable amount annually in interest, depreciation and obsolescence. The amount of stock at the end of the year 1924 varied in value from £2,230,548 on the Southern to £9,742,973 on the London, Midland and Scottish. For every mile of single track the respective companies owned:—Southern, £411; G.W.R., £437; L. and N.E.R., £449; and L.M. and S.R., £493 worth of stores.

THE court of inquiry that has dealt with the dispute as to the shopmen on the Great Central section of the London and North-Eastern Railway and on the Cheshire Lines Committee's system has reported that in the absence of exceptional circumstances the conditions of employment of railway shopmen should be uniform throughout the country. There are, however, "exceptional circumstances" in this case. The court is not satisfied that the application was unanimous—the crafts unions strongly opposed it—and the concession would cost £90,000 a year, "a sum which the companies can ill afford at the present time." It is suggested that the question be reviewed in a year's time.

THERE were many complaints last year of the lack of accommodation and of the provision of unsuitable rolling stock on the long-distance excursion trains from Lancashire. The Lancashire Parliamentary Committee—a body of all the Lancashire Members of Parliament—took the matter up with the railway companies, which replied that special appeals were made to the public to book in advance. Only about twenty passengers responded, but the trains would be swamped by heavy bookings beyond expectation on the day of the excursion. As a result of the discussions with the companies it has been agreed that, for trains that require corridor stock, tickets must be taken twenty-four hours before the day of the excursion.

THE new engine depot of the Southern Railway at Exmouth Junction will have an engine shed 270ft. long and 235ft. wide, built in ferro-concrete. It is to be an end-on shed, with twelve roads and a repair road. The yard is to be entered by facing points in the main line and engines, on arrival, will proceed direct to the cleaning and inspection pits, an automatic coaling plant and the turntable and thence to the shed. When the existing shed has been displaced, its sidings will be thrown out of use, and on the site so set free new permanent way shops and new carriage and wagon shops are to be erected. A marshalling yard is being provided which will have ten sidings, giving accommodation for 400 wagons. Six of the sidings are already in traffic.

Notes and Memoranda.

IN the quarterly report of the statistical department of the Swedish Government it is stated that the world's output of ball bearings is approximately 200,000 a day, and that the S.K.F. factories use 20,000 tons of Swedish steel a year in the manufacture of ball bearings.

AN expedition, under the charge of Dr. H. T. Barnes, McGill University, is going to Greenland in June with the object of experimenting on the breaking up of icebergs by means of Thermit. The idea is to reduce them in size so that they will not reach the shipping routes.

IN a recent speech in Sydney Mr. James Fraser, the chief railway commissioner of New South Wales, said that "in New South Wales wagons are loading to 70 and 75 per cent. of their capacity, and they run a better mileage per day than any other railway operated by white labour. America has set herself the goal of 36 miles per wagon per day, and Victoria's ideal is 30. In New South Wales last year the mileage was 46."

A STUDY of the mechanism of corrosion and the factors effective in its control in steam power plant operation is being conducted by the Bureau of Mines, Department of Commerce, at its Pittsburgh experiment station. The purpose of this investigation is to obtain data on the amount of hydrogen concentration that should be maintained in the boiler water in order to reduce corrosion to a negligible proportion. In economiser tubes and feed lines especially, dissolved oxygen in the water causes a great deal of corrosion. Elimination of dissolved oxygen can be partly effected by deaeration, but this does not wholly remove the oxygen. If the hydroxyl concentration can be controlled to suit the conditions, it can be utilised to control the oxygen.

IN a paper on "Motor Band Losses," appearing in the January issue of the *Journal* of the American Institute of Electrical Engineers, Mr. T. Spooner shows that railway motor band losses are of appreciable magnitude, sometimes sufficiently large to be detrimental to the cooling of the machine. By tests of a small machine checked against those of a large one, the band losses are found to vary according to the 1·7 power of the frequency and from the 1·35 to the 1·8 power of the induction, depending on the width and type of band. These losses are shown to be due chiefly to the change in the radial component of the flux as the band passes by the pole tip. For average bands, about 15 per cent. of the losses—hysteresis and eddy current losses—are due to the tangential flux in the bands. A typical set of curves is given for calculating band losses.

A SERIES of gas plant tests, designed to obtain information regarding the proposed gas plant testing code of the American Gas Association, will be made by the Bureau of Mines in co-operation with the Association. Arrangement has been made by the American Gas Association for six plants in the East to operate for approximately one month each, using exactly the same coal. During this operation complete records will be kept of all measurable quantities involved in the plant operation, so as to obtain the productive and thermal efficiencies of each stage and of the plant as a whole. Another phase of the investigation is to determine the characteristics of the cokes produced in the co-operative tests with the gas association from the same coal by six different types of coking furnaces. All the physical and chemical properties of these cokes will be measured following the specifications of the American Society for testing materials where such have been formulated. Standard and special combustibility tests will also be made, as well as a special test of the suitability of the cokes for use in household furnaces.

DURING a recent exhibition in Paris some spectacular performances on the river Seine were carried on by means of a specially built and installed array of luminous fountains. Along each side of the Alexander Bridge a steel pipe 1ft. in diameter with 9000 small holes was suspended, and a 200 horse-power motor pump delivered water under pressure to these two pipes. The closely spaced water jets formed a parabolic curtain on each side of the bridge. A large number of 2000 candle-power floodlights, arranged under the bridge and out of sight, illuminated these two curtains brilliantly. As it was necessary to point all of these floodlights downward, their reflectors had to be water cooled to prevent overheating. Near the bridge several floating luminous fountains were installed. These were specially designed for the purpose and entirely self-maintained. They consisted of round steel caissons of 23ft. diameter, containing two motor pumps for the high-pressure water and three rings of flood-lamps, throwing beams of light through watertight glass panels upward upon the rising jets of water. There was room within the caisson for an attendant, who changed colour filters on the flood-lamps. Harmonious colour effects were assured by means of telephone interconnections between the fountains and to the shore.

A PROCESS of preserving meat for export by dipping in a hot liquid, which, when dry, forms an airtight skin, has, it is reported, been discovered by a Mr. H. Rees, of Benoni, near Johannesburg. An official analytical certificate has, it is stated, been received from the Government analytical Department, Pretoria, that a sample of meat subjected to the new process was fit for human consumption fifty days after treatment. The method is said to be exceedingly simple. All that has to be done is to dip a carcase in a tank of very hot liquid—the formula for which Mr. Rees guards very closely. On the removal of the carcase from the tank, the liquid dries in a few minutes, and forms a skin over the meat. When set the skin becomes like rubber, and anything that bumps against it is bounced off. The skin cannot be torn, and in order to peel it off an incision is made, and the covering drawn off in much the same way as a sock is removed. According to report, the carcase five minutes after it comes out of the tank is fit for any amount of handling, and the skin after dipping is of such condition that bruising of the meat is eliminated. Dipped in the liquid all baccili on the outside are destroyed, and it is impossible for germs, air, or dust to penetrate the skin. The cost for a quarter of beef is given as being 2s. 6d., but if the skins be melted down and used over again the ultimate cost comes to about 9d.

Miscellanea.

AN aeroplane has been built by Mr. A. V. Roe with which it is hoped to attain a speed of from 170 to 180 miles per hour. It is fitted with a direct-drive Napier-Lion engine.

THE Glasgow Corporation is considering the construction of a new bridge across the Clyde at Finnieston, at a cost of about £1,000,000. It is proposed to allow a headroom of 76ft. at high water under the central span.

ON Thursday, the 11th inst., the third large German destroyer, B 112, was raised at Scapa Flow by Cox and Danks, Ltd. The vessel was found lying on its side. It is 1300-ton boat, and is the twenty-first destroyer to be raised.

THE five machines to be used by Imperial Airways for the Cairo-Karachi service will be built by the De Havilland Aircraft Company. They will each be fitted with three air-cooled 400 horse-power Bristol Jupiter engines. The carrying capacity is to be 2900 lb.

THE Royal Air Force flight from Cairo to the Cape, with four machines, will start on March 1st from Heliopolis Aerodrome. The machines are Fairey-Napier 3D land-going aeroplanes. They have a top speed of 120 miles an hour, and carry petrol for flights of six hours.

CONFERENCES have lately been held in Brussels between German and Belgian wire producers with a view to coming to an agreement. The Germans have promised to supply to the Belgians particulars of the organisation of the German industry, on receipt of which the Belgians are to form a wire syndicate.

THE first of the six Amphibian flying boats being built in this country for the Royal Australian Air Service was launched at the Submarine Aviation Works, Southampton, on the 5th inst. The flying boats are being shipped in time to carry out in a few months a survey of the Great Barrier Reef, which extends along the Eastern coast of Australia.

A SITE has been awarded in the centre of Asuncion on which it is proposed to construct a large broadcasting station. The construction will be under the control of the Ministry of War and Marine, which will purchase equipment by means of public tenders. The opportunity will be taken to organise a broadcasting company under the management of the municipality of Asuncion.

THE French Government has decided to offer prizes to French constructors of aeroplanes creating records. The standard prize offered for a new world's "record" which remains a 'record" at the end of the year is 140,000 f. —rather over £1000—for the machine and 60,000 f. for the engine. Special prizes are offered for the "record" for distance or duration in a single flight without refilling, and for height.

IN order to meet the extra traffic which is expected to result from the establishment of a direct line of Italian steamships carrying emigrants between Genoa and Rosario, it has been decided to convert Rosario into a second-class port. For this purpose application will shortly be made to Congress for a large monetary assignment; but whether the Government will sanction the grant is considered doubtful.

GREAT store is set on the success of the conference which has been summoned to Geneva on March 25th to consider propositions concerning the redistribution of broadcasting wave lengths between European stations. These propositions, states the *Wireless World*, are the result of investigations extending over four months. The conference will consist of all existing or projecting broadcasting organisations, and will be held at the Palais de Nations, which has been lent by the Secretariat of the League of Nations. The conference will be preceded by a general assembly of old and new members of the International Broadcasting Union.

IT is announced from Managua that a project has received the initial approval of the Nicaraguan Government for the construction of a series of breakwaters at regular intervals in the Bay of Corinto on the Pacific coast, in order to protect this important western port from the encroachment of the sea. The harbour is connected by rail with the town of Leon (35 miles) and with Lake Nicaragua (58 miles), but it is seriously inconvenienced by the lack of arrangements for coastal steamships. The construction of breakwaters of sufficient length and height would enable ocean-going steamers, which now have to anchor far out in the bay, to enter the port for loading and discharging.

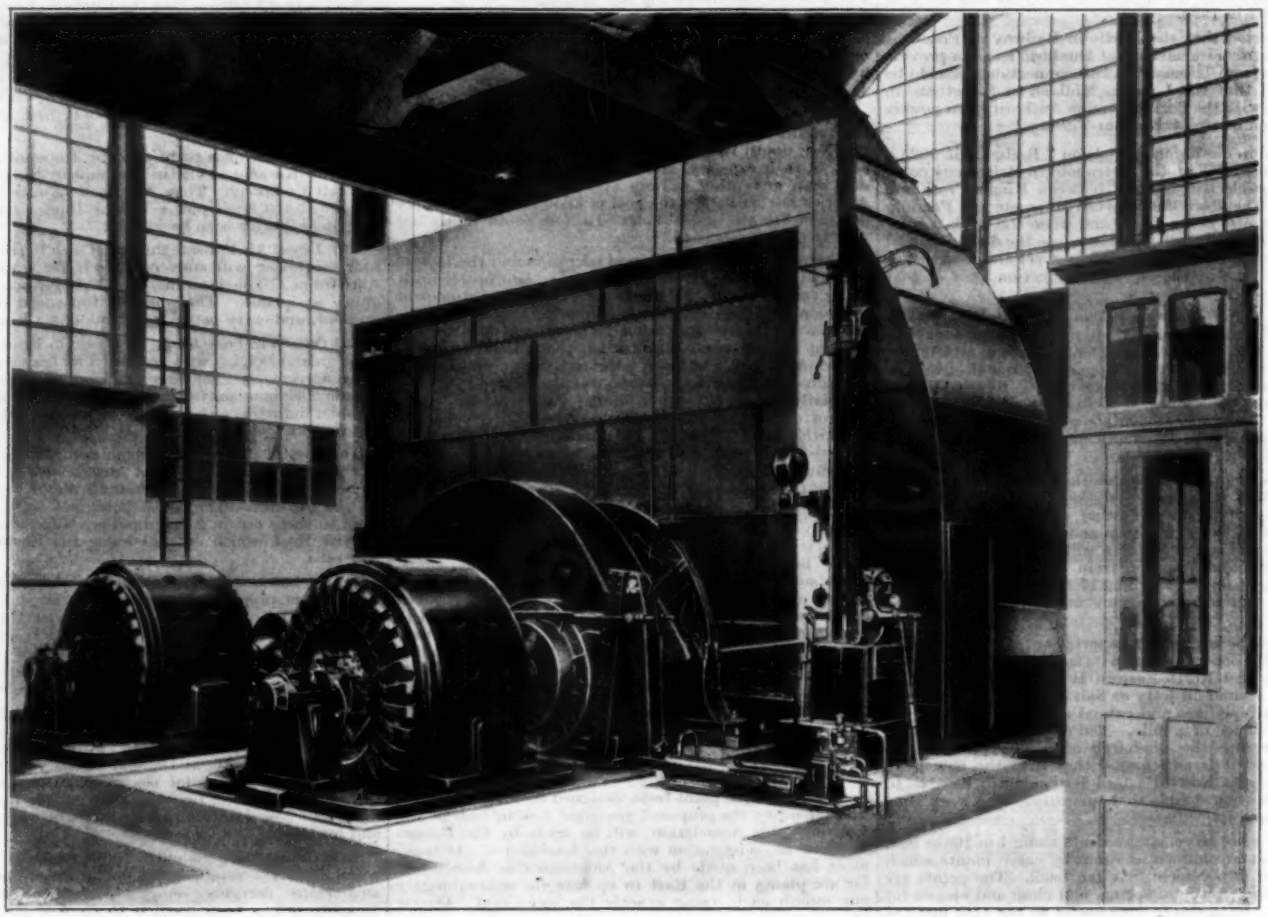
THE monthly return by the National Federation of Iron and Steel Manufacturers shows that the production of pig iron in January amounted to 533,500 tons, compared with 503,400 tons in December and 574,500 tons in January, 1925. There were 144 furnaces in blast at the end of the month, a net increase of three since the beginning of the month, seven furnaces having been put into blast during the month and four either damped down or blown out. The production includes 178,100 tons of hematite, 183 200 tons of basic, 121,700 tons of foundry and 21,800 tons of forge pig iron. Production of steel ingots and castings amounted to 635,700 tons, compared with 606,800 tons in December, when production was affected by the Christmas holidays, and 605,100 tons in January, 1925.

ACCORDING to newspaper estimates of the situation, Montreal does not consider the United States as really serious in the proposal to deepen the New York State Barge Canal to 25ft., and thus to divert heavy Great Lakes traffic from the St. Lawrence system. The *Canadian Engineer*, however, is disposed to think that this attitude is by no means a safe one to take. There is in many quarters in the United States an extreme nationalistic attitude towards questions of this kind, and the pride of country and its possessions and achievements would unquestionably go a long way towards forcing a decision to deepen the barge canal in order that American Great Lakes traffic might be entirely handled in American territory. While it cost nearly 200,000,000 dollars to deepen the old Erie Canal to 12ft., it is now estimated that perhaps another 500,000,000 dollars would give a 25ft. waterway through to New York and enable 90 per cent. of the ocean freighters to pass between the Great Lakes and Atlantic.

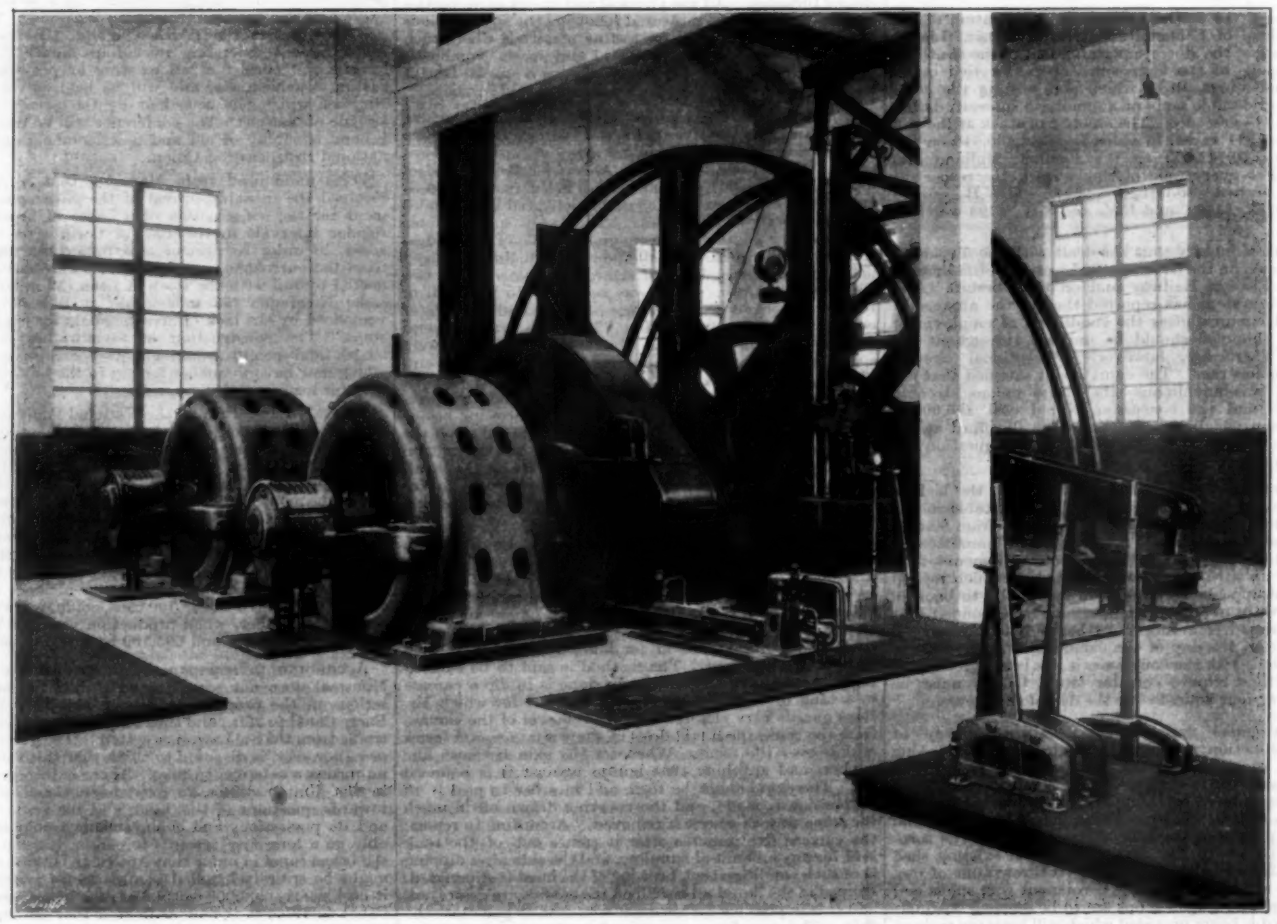
ELECTRIC WINDING GEAR AT THE MONCEAU-FONTAINE COLLIERY, BELGIUM

LES ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, ENGINEERS

(*For description see page* 211)



1150 H.P. WINDING GEAR FOR NO. 4 MINE



2000 H.P. WINDING GEAR FOR NO. 18 MINE

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THE ENGINEER.

FEBRUARY 19, 1926.

The New Cruisers.

WITH the launch of H.M.S. Suffolk at Portsmouth on Tuesday the process of rebuilding our cruiser fleet on modern principles may be said to have begun. Four sister ships are soon to follow her down the ways, while the two Australian vessels which are under construction on the Clyde should be ready to go afloat before the end of the year. In view of the official practice of treating details of new construction as confidential until the vessels themselves pass into service, it is not possible to compare our new "County" cruisers with the newest foreign designs, which, by the way, have been widely published. We know, however, that the Suffolk and her sisters conform to the requirements of the Washington Treaty, in that their displacement is restricted to 10,000 tons at light load, and the calibre of their guns to 8in. But no artificial limit has been set to their speed, and it is freely stated that in this attribute they will excel the swiftest cruisers now building abroad, some of which have a legend velocity of 34 knots. To achieve even this speed with a vessel of 10,000 tons, burdened with a heavy armament of 8in. guns, it would be necessary to dispense entirely with armour protection, and we do not think that British naval opinion would approve such a sacrifice. Though a combination of gun power and speed may still represent the tactical ideal, war experience has bred a new respect for defensive qualities. Admiralty views on this question were reflected in the remarks made by Captain (now Rear-Admiral) Sir Alfred Chatfield when discussing the design of H.M.S. Hood at a meeting of the Institution of Naval Architects in 1920. Referring to the emphasis which had been laid on speed as the chief desideratum in naval warfare, he said that those who had fought at sea held a different opinion. The claim that speed enabled a commander to choose his range and also to decide whether to engage the enemy or not, had not been upheld by actual experience. Assuming it to be the duty of a British ship always to engage the enemy, speed was not wanted for running away. As for choosing the range, "those who have been in action know perfectly well that in ninety cases out of a hundred the factor which determines the range at which you will fight is the Clerk of the Weather. If you cannot see more than 10,000 yards it is no good having speed which would enable you to keep 25,000 yards off. You have got to come in to the distance at which you can see the enemy, and when you come into that range then the man who has got plenty of speed but no protection finds himself in a very awkward position. That is what has happened time and again." Coming from an officer who commanded fast ships throughout the war, these remarks on the relative value of speed merit the most careful consideration. It is true that Admiral Chatfield was speaking of capital ships, but his general thesis is just as applicable to cruisers. We are, therefore, reasonably confident that in the design of our latest cruisers a balance has been struck between the rival claims of speed and endurance to punishment.

At the same time it will clearly be impossible to endow these ships with the measure of protection they might have received but for the Treaty restriction on displacement. If they are ever called upon to fight their adversaries are likely to be ships mounting the 8in. gun. To resist the projectiles of this weapon, except at very long range, 6in. armour at least is required, even allowing for the chances of oblique impact. Yet the weight involved by a partial belt of this thickness would be prohibitive in a 10,000-ton ship of great speed and heavy armament. In the Hawkins, which bears a general resemblance to the Suffolk, the maximum thickness of the vertical plating is 3in., with 1½in. armour on the decks. It will be surprising if the Suffolk shows any improvement on this system of protection. Cruisers of the "Treaty" type will therefore be exceptionally vulnerable to gunfire, and perhaps not less to under-water attack. They will have the power of delivering heavy blows with small capacity for resisting them. But for the fact that this peculiarity will be common to all cruisers, whether British or foreign, built under the rules of the Treaty, it would afford grounds for trenchant criticism of the new ships. As it is, we own to a feeling of regret that circumstances should compel us to build vessels of which the design, however unavoidably, does violence to a cardinal principle of man-of-war construction. There is, however, no alternative. We could not remain passive while other Powers were turning out cruisers superior in speed and gun power to our best ships. A glance at tables of foreign construction is sufficient to show that we have deferred our programme of replacement to the very last moment. Since the war forty-seven cruisers have been laid down by the various maritime States, and of this total only seven are British. At the present time there are twenty-nine cruisers in service with speeds of 33 knots or more. Of these, only two are British. This is not a position which can be allowed to continue, having regard to our immense volume of floating trade and our dependence on overseas supplies. No time is to be lost in laying the keel plate of a new "County" cruiser on the Portsmouth slip vacated by the Suffolk, another is to be laid down at Devonport, and orders for two others have just been placed, one with William Beardmore and Co., Ltd., and the other with R. and W. Hawthorn, Leslie and Co. Ltd. In the coming financial year three more cruisers are to be laid down, but of this trio only one will be of the "County" or "A" class. The others are to be of a smaller type, designated the "B" class, and displacing about 8000 tons. In each succeeding year, from 1927–28 to 1929–30 inclusive, one "A" and two "B" ships are to be built. Consequently, if this programme is adhered to, we shall eventually have sixteen new cruisers of 10,000 tons, mounting 8in. guns, and seven of 8000 tons, probably carrying lighter metal. In actual sea speed—as distinct from the often illusory trial speeds attained under artificial conditions—and in sea-keeping qualities, these twenty-three ships will, no doubt, be equal to the best foreign cruisers of coeval design. This total, it should be observed, includes the Australia and the Canberra, which are being built for the Royal Australian Navy. We shall possess, in addition, the four "Improved Birminghams," of 9750 tons and 30–31 knots' speed, armed with 7.5in. guns; the Emerald and the Enterprise, of 7600 tons and 33 knots; and the Adventure, a cruiser-minelayer of 7260 tons, the speed of which is not yet known. This will give us a grand total of thirty ocean-going cruisers. The number is certainly not excessive, and is, in fact, twenty-two less than the establishment which the Admiralty, only two years since, declared to be the minimum consistent with future requirements. It is to be hoped, however, that measures will be taken at the proper time for continuing the systematic replacement of obsolete material, a policy that is more economical than the practice of suspending construction for a term of years and then making a frantic effort to overtake arrears.

While there is, as we have seen, a shortage of oceanic cruisers, we are fairly well provided with vessels adapted for duty with the fleet, either as scouts, screening ships, or flotilla flagships. We have thirty-one "D" and "C" class cruisers, at

least half of which are fully effective, and should remain so for a long time to come. At some future date the whole question of cruiser policy will have to be reviewed. Ships of 10,000 tons, costing £2,000,000 each, may be essential for commerce protection, but for fleet service they are needlessly large. Even the projected "B" ships are 2500 tons heavier than the largest unarmoured cruisers that were attached to the Grand Fleet during the war. It should be possible to design a fleet cruiser with a speed of 33 knots and an adequate 6in. armament without going beyond 6000 tons. Japan in late years has built many vessels approximately of this type, which appear to be giving satisfactory results. The problem may be simplified by new advances in the science of ship construction and engineering. Sir E. T. d'Eyncourt has publicly referred to the existence of Colville's controlled elastic limit steel, which combines lightness with extraordinary strength, and which, if employed for shipbuilding, would enable hull weights to be cut down very considerably. Further economies in weight may be effected by the adoption of boilers and turbines for higher pressures, a development soon to be put to practical test in the experimental steamer now being built on the Clyde. Admiralty constructors are doubtless keeping fully abreast of technical progress, and particulars of their latest cruiser design will be awaited with interest by the engineering community.

Quenching.

THE hardening of steel by quenching is an ancient metallurgical operation, and one which, until recently at all events, has been surrounded with mystery. Some of that mystery, however, may be the result of more or less conscious mystification on the part of those who sought to magnify the importance and difficulty of the craft they practised. Not only has the "art" of quenching itself been magnified in this way, but special virtues have been ascribed to the waters of certain favoured localities, while all manner of prescriptions—some of them amusing and others simply disgusting—have been gravely put forward as yielding results which could not be obtained otherwise. At the present time a good deal of "mystery" still remains, but the practice has been rendered far more difficult and complicated by the introduction of a number of special steels, each of which requires its own proper treatment, while "hardening" and heat treatment processes of an analogous kind are now applied to other materials besides steel.

The scientific aspect of "hardening" is perhaps at the moment in a transition stage. As regards the explanation of what occurs in the interior of steel during quenching and tempering, while there are still wide divergences of opinion, a simple and rational view appears to be steadily gaining ground, although a few of the multitudinous facts are still difficult to explain. We are, however, at the moment, concerned rather with the mode of action of the quenching bath than with the internal physics of steel, and there the position is not yet so satisfactory. It is true that we have come to recognise that the only function of a quenching bath is to produce cooling of the hot steel, and that the physical effect on the steel depends almost entirely upon the single factor—the rate of cooling produced. A number of investigators, first Le Chatelier and later Benedix, have accomplished the difficult task of measuring the rate of cooling of specimens of steel during quenching, and their results have afforded an important insight into the actual cooling effect of different baths. As a result, we know that water gives the most rapid cooling, particularly when the water is itself cold and when both its specific heat and fluidity are increased by the addition of a certain percentage of alcohol; hot water causes much more gradual cooling than cold, and the effects of quenching in hot water are found to approximate to those obtained with oil. This is ascribed to the rapidity with which hot water gives rise to an envelope of steam around the immersed hot steel, and it is supposed that the effect of using brine or any other salt solution is in part at least due to the raising of the boiling point which follows its use. On the other hand, in considering such an explanation, the effect of differences in viscosity and specific heat must not be forgotten. How large is the influence of specific heat becomes evident when it is shown that mercury, in spite of its high thermal conductivity, high boiling-point and moderate viscosity, is a less severe quenching medium than oil. "Oil" itself is a vague term, including a wide range of substances differing notably in regard to the physical properties just named; from the practical point of view, however, these wide differences matter less than might be feared, owing to the fact that where the rates of cooling are so relatively slow as they are in oil quenching, small variations of rate make far less difference than they do where chilling is extremely rapid. That, as we suggest below, is perhaps the greatest advantage of oil quenching. The object in selecting a quenching bath for any given purpose is, as a rule, to secure the greatest possible speed of cooling without risk of cracking the steel. It is true that for many purposes steel, although hardened by quenching, is not required in the fully hardened condition, and is, indeed, always subsequently tempered in order to make it tougher and less brittle. In such circumstances, it is sometimes suggested that it is unnecessary or even undesirable first to harden it fully and that the desired physical condition can be better and more safely obtained by a less rapid degree of chilling which never fully hardens the steel. There is, however, good reason to doubt whether the condition of a properly hardened and tempered steel can ever be duplicated or equalled by a piece which has been merely "toughened" by slower cooling or by chilling from a safer, but lower, temperature. In the fully hardened steel we have an exceedingly fine state of division and uniform state of dissemination of some of the constituents, which cannot be obtained in any other way, and this uniformity of distribution is retained after quenching, although the size and perhaps the nature of the particles is altered. If it be granted that preliminary full hardening is desirable wherever possible, then the choice of a quenching bath should be made with the object of attaining the most drastic chilling effect that can be produced without cracking the steel. Much, of course, must depend not only on the steel used, but on the size and shape of the pieces to be quenched. For instance, Mr. Brayshaw has shown that for one particular steel and shape of object, there is a definite preliminary heat treatment which largely eliminates cracking, even under severe conditions, and there is probably room for much further work on these lines. Many attempts have also been made to modify the behaviour of steel while undergoing hardening in such a way as to lessen the risk of cracking, and some alloy steels are undoubtedly much less sensitive than others. But the bath itself plays a predominantly important part, which, it would seem, is not to be measured solely by the rate at which a standard piece of steel will be chilled when immersed. Apparently, there are other factors which affect the behaviour of the steel. Uniformity of action is perhaps the most important. In water quenching the formation of a steam envelope is of primary importance, and perhaps gives rise to more trouble than any other factor. Violent agitation, of course, serves to avoid this type of trouble, but does not entirely eliminate it. The use of spray in place of immersion is another device, while quenching by means of powerful jets of water has also been advocated and is used in exceptional cases. In oil there are corresponding risks of non-uniform action, since boiling occurs, while there is also a formation of a carbonised layer on the surface of the steel when first immersed. There is, however, the very great difference that with the slower rate of cooling in oil, local differences cause much less marked effects, and there is more time for mechanical agitation and thermal conduction to equalise conditions in adjacent parts.

An interesting sidelight on this question is provided by the practice, recently developed, particularly in America, of using quenching baths consisting of an oil-water emulsion. The oil-water mixture can only be kept emulsified by constant agitation, but when this is done, the mixture produces a quenching effect nearly as vigorous as water, but, it is claimed, with the freedom from cracks characteristic of oil quenching. If this claim is correct, we have not only a most valuable quenching method for practical use in difficult cases, but a phenomenon of the greatest interest as bearing upon the mechanism of quenching. Careful analysis of the conditions suggests that, as a rule, cracking during quenching is the result of non-uniform action of the bath rather than of mere rapidity of cooling. Given a piece of steel of moderate size, of perfectly uniform composition and texture, and free from defects or non-metallic enclosures, it would seem that it could be safely chilled at any desired or attainable rate, provided that the temperature of all parts of its surface fell at precisely the same rate. It is, however, a case of unstable equilibrium—*i.e.*, if any part is chilled more rapidly than another, the whole structure is apt to break down with the formation of cracks. This view cannot, of course, be proved by experiment, since "perfect" specimens of steel are not obtainable, but even if it is not entirely true, it suggests the correct idea—that uniformity of chilling is essential to successful quenching of the severer types. By more careful study of the uniformity of the steel and of its surface condition, and particularly of the behaviour of the quenching baths, it should be possible to obtain results in the hardening of steel which at present are only rarely achieved.

Literature.

SHORT NOTICES.

Proceedings of the Fourth International Congress of Refrigeration. London: The British Cold Storage and Ice Association. Two volumes, 45s. in paper, 55s. in cloth.—The report of the "Proceedings" of the Fourth International Congress of Refrigeration, which was held in London during June, 1924, has recently been published, and the two volumes contain a vast amount of useful information associated with low temperatures; but, in view of the fact that they run to over 1800 pages all told, it would be futile to attempt to give an adequate description of the contents here. The report is prefaced by a brief survey by Mr. A. Barrier, director of the International Institute of Refrigeration, who points out that there have been considerable advances in the art since the last Congress was held in Chicago in 1913. Much of this progress has taken place on the theoretical side of the subject, and interests engineers only indirectly; but many of the papers read at the Congress are of an essentially mechanical engineering nature, and, seeing that they were contributed by engineers from all over the world, should be of special interest to British manufacturers of refrigerating machinery. It is not, however, only manufacturers among engineers who will find valuable information in these volumes, as such subjects as liquid air explosives, the transmission of heat, the ventilation of mines, heat insulation, the use of refrigeration in rubber manufacture and lubrication are dealt with. There is a good index, and the illustrations are well done. In this connection it is noteworthy that the cuts are arranged conveniently to the reading matter, and are not bunched together at the end of the papers, as is so often the case in this class of publication.

Practical Road Engineering. By H. E. Goldsmith. London: Crosby Lockwood and Son. 1925. 25s.—This book is largely based on the author's previous work, "Modern Road Construction and Maintenance," which, in turn, was written in the light of his experience as executive engineer in charge of roads, Hong Kong; but in the new volume there is much additional matter. In the circumstances it is only natural that the type of road dealt with most extensively is that constructed in rough mountainous country, but adequate attention is paid to more easy work. There are brief illustrated descriptions of the plant required in road making, including some asphalt-mixing machines. The processes of laying various classes of surface are dealt with individually, and typical specifications are given, while the clerical work involved in estimating costs is explained. A short chapter is devoted to skidding, and the author's remedy is described.

Some Reminiscences: Seventy-five Years' Work in Civil Engineering. By Professor Henry Adams. London: The Institution of Structural Engineers. 1926. 2s. 6d. net.—This is a little book of reminiscences for those who themselves have passed the meridian. To youth many of the little events recorded will appear trivial, but older men will enjoy recalling, with the genial professor, the little memories of fifty and sixty years ago. The German Gym, Pepper's Ghost, the explosion of a powder barge in Regent's Canal, Stokes the Memory Man (who forgot his umbrella), Dr. Lynn the conjuror, General Tom Thumb—they take the mind back to the little things that interested us years ago, which in the course of time have acquired a charm all their own. About all such things and many connected with a profession which he has adorned so long, Professor Adams chatters agreeably, throwing in now and then an apposite story or a philosophical observation.

BOOKS RECEIVED.

Draught and Capacity of Chimneys. By J. G. Mingle. London: The Combustion Publishing Corporation, 84, Kingsway, W.C. 2. Price 16s. net.

An Experiment to Determine Corrections to Sounding in River Gauging. By P. Phillips. Cairo: Government Press, Dawawin P.O. Price P.T. 5.

Journal of the Institute of Metals. Vol. XXXIV. Edited by G. Shaw Scott. London: Institute of Metals, 36, Victoria-street, S.W. 1. Price 31s. 6d. net.

Vibrations in Engines and Machinery. By A. T. J. Kersey. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

Studies of Bond between Concrete and Steel. By Professor Duff A. Abrams, being Bulletin No. 17 of the Structural Materials Research Laboratory, Lewis Institute, Chicago. Published by the Laboratory. 1925.

Annali dei Lavori Pubblici, già Giornale del Genio Civile (Ministero dei Lavori Pubblici, Consiglio Superiore). Anno LXIII., No. 11, Novembre, 1925. Rome: E. A. de Gaetani, Via Torre Argentina, 47.

Second Technical Conference of State Utility Commission Engineers, March 6th and 7th, 1924, being No. 68 of the Miscellaneous Publications of the Department of Commerce of the United States Bureau of Standards. Washington, D.C.: The Superintendent of Documents, Government Printing Office. 1925. Price 15 cents.

H.M.S. Suffolk.

AN interesting feature of H.M.S. Suffolk, whose launch is recorded in our Seven-day Journal to-day, is revealed by our engravings. It is the pronounced bulge protection, which appears to extend over the greater part of the water-line. Judging from launching views of the Nelson and the Rodney, those battleships are without bulges, though the essential elements of this method of protection are probably incorporated in the underbody, which has an extreme breadth of 106ft. That the bulge should now reappear, more or less in its original form, in a class of cruisers understood to have been designed for high speed, may occasion some surprise. It is believed, however, that tank experiments with models have shown that bulges of a certain form are not incompatible with great speed. In the case of the Hood, the loss of speed they entail is only a fraction of a knot, and this loss is due, not to increased resistance, but simply to the additional weight of the bulges. As Sir E. T. d'Eyncourt has pointed out, the modern form of bulge, as developed in the British Navy, enables the ordinary form of ship to be maintained, and what is inside the bulge is purely internal so far as the shape of the ship and the resistance are concerned. The bulge is so constructed that the explosion of a torpedo would spend itself upwards and outside the side of the ship proper. This would not only prevent the blowing-in of the ship at the point of impact, but would save the lives of men who were in the vicinity. Further, bulge protection preserves the integrity of the main bulkhead, since an explosion taking place inside tends to destroy the stringer and shear strake, injuries that might seriously impair the general seaworthiness of the ship, especially in heavy weather. It is an established fact that no vessel equipped with bulges was sunk by underwater attack during the war.

The sides of the Suffolk fall inboard until they meet the bulge, apparently in such a manner that a perpendicular dropped from the edge of the deck would just touch the outer curve of the bulge. This inward slope reduces the danger from plunging fire, as it would be virtually impossible for projectiles to impinge on the hull at an angle favourable to penetration. Finally, the bulges fitted to the Suffolk appear to be deeper than those with which earlier cruisers, notably the "Improved Birminghams," are provided. We may therefore conclude that the Suffolk and her sisters will have excellent protection against torpedoes, besides being less vulnerable to the effect of heavy aircraft bombs detonating alongside.

IT is said that Professor N. Vittorf, of the Institute of Economic Mineralogy and Petrography, at Moscow, has invented a process by which the aluminium sulphate produced in the extraction of the metal from bauxite or clay is twice treated with alcohol, the effect of which treatment is to reduce the iron content of a solution from about 3 per cent. to 0.0004 per cent., or virtually to nothing. This method, by the way, will, it is claimed, make possible the working of bauxite beds which have hitherto been considered to be of too low a grade, as well as some high-grade deposits that have a large iron content.

Some Technical Aspects of the Commercial Airship.*

THE alloy hitherto invariably used for the construction of the framework of rigid airships is "duralumin." Like steel, duralumin suffers from corrosion if unprotected, and after prolonged exposure to moist air a thin whitish film of oxide will appear on its surface. This may readily be prevented, either by applying a suitable varnish or by the electrolytic methods recently developed by Doctor Bengough.

Some interesting notes on the subject of the possible gradual deterioration of duralumin have recently been published by Professor C. F. Jenkin in which he deals with the suggestions made from time to time that duralumin may corrode, either on the surface or throughout its mass, or that its crystalline structure may change by growth of some of the crystals, or that it may become brittle or change its dimensions owing to a continuous change like that known as ageing, by which the metal hardens after heat treatment, or finally that it may become brittle owing to vibration.

Professor Jenkin states that if *preserved from corrosion* duralumin does not deteriorate with time, and that none of the suggested actions produces deleterious effects. Corrosion, on the other hand, does produce serious results, but surface corrosion is easily seen, and if unaccompanied by intercrystalline corrosion only affects the strength of the members by reducing their section. Fortunately, surface corrosion does not appear to attack the joints specially or to penetrate between the surfaces, where riveted together, so that when inspecting a structure there is no reason to fear the existence of hidden corrosion worse than what can be seen; and while there is no evidence that intercrystalline corrosion has ever occurred without surface corrosion, it is not yet certain whether under special conditions it might not do so. This point is being investigated at the National Physical Laboratory.

When inspecting a structure the best method of detecting intercrystalline corrosion is to cut narrow strips as flat as possible from the suspected parts and to apply a bending test such as bending round a pin and comparing the results with similar tests made on sound material.

There is a growing tendency to consider the use of stainless high tensile steels in certain parts of the framework, in preference to duralumin, but while weight for weight high tensile steel is of equal strength, parts of the requisite lightness made from this metal would, owing to their extreme thinness or alternately their small section, lack structural efficiency. Great advances in the design of girders formed from stainless steel sections have recently been made in connection with aeroplane spars; but it is doubtful whether the same structural efficiency can be obtained when compared with girders made from duralumin for airship work.

The great majority of the girders used in airship construction are triangular in section, having three main boom members at the apices of the triangle connected together by bracing pieces which form a lattice work on each of the three sides. The riveting of work of this type is necessarily exceedingly light, and pneumatically operated riveting machines have been developed which enable uniform results to be obtained without risk of injury to the materials.

The design and manufacture of the gas bags of a rigid airship form quite a distinct branch from the engineering side, and here again there is scope for improvements in materials and technique. At present the most satisfactory materials for the manufacture of bags are cotton or linen fabric weighing from 60 grammes per m.² upwards, lined with one or two layers of goldbeater's skin. It has long been clear, however, that as the products of some two million oxen are required to line the bags of a ship of modern size the demand will rapidly outgrow the supply, and an efficient substitute has recently been produced as a result of the work of Major P. L. Teed, A.R.S.M., and there is no doubt that we are now in a position to produce first-class bags from synthetic materials.

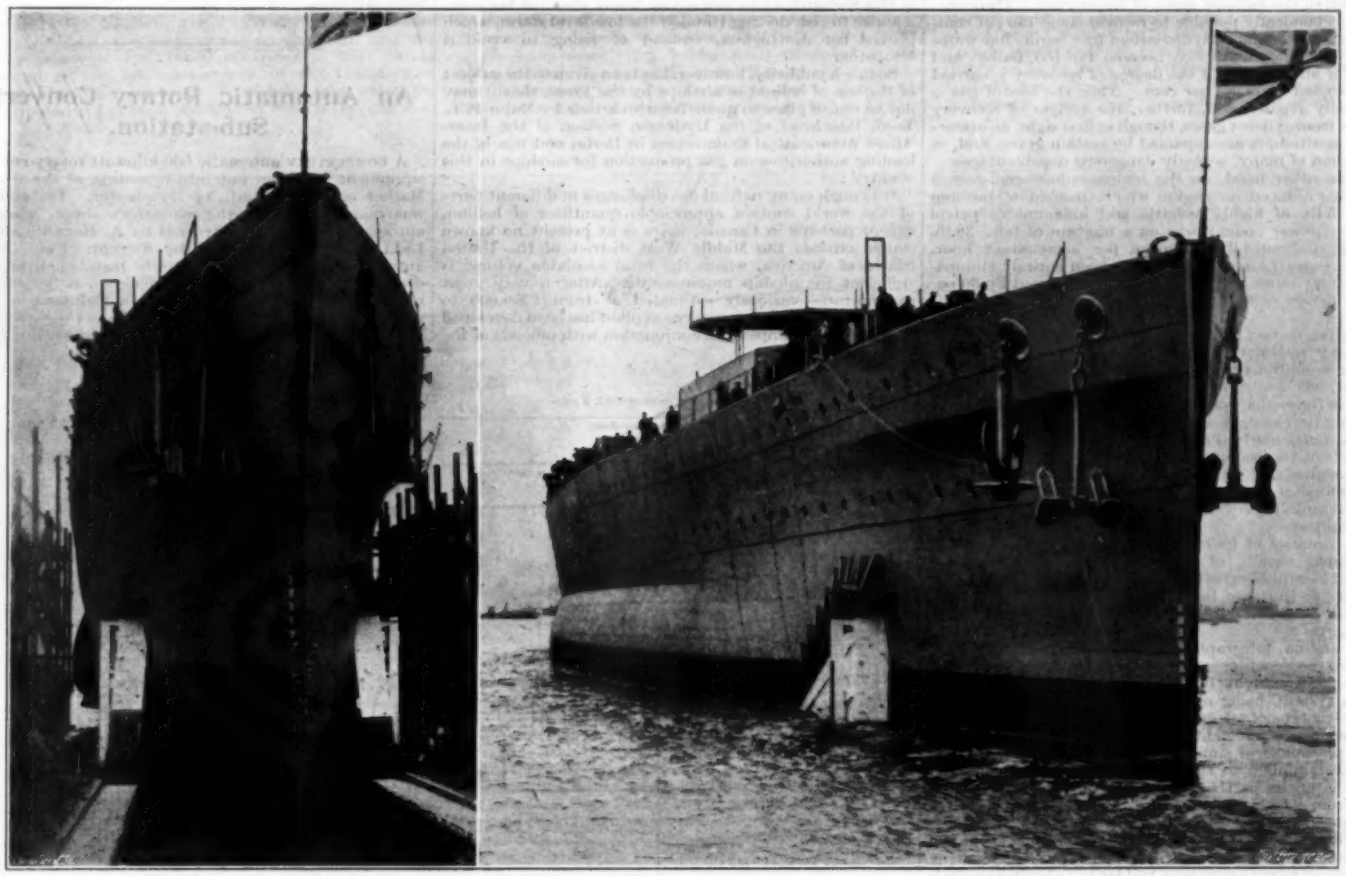
There is little to be said about the outer cover, except that it forms perhaps the least satisfactory part of a modern rigid, and may be one of the greatest causes of loss of efficiency in flight. Made from a strong linen fabric, suitably treated and doped to resist the wear and tear of weather and sunlight, its performance depends to a higher degree than almost any other part, on the skill of the staff employed on its manufacture and fitting. Apart from its sunlight resisting qualities—of great importance when work on tropical routes is considered—its tautness and smoothness are of primary importance. Like a foul bottom, a slack and flapping outer cover can, from reliable observations, reduce the speed of a fast ship by over 10 per cent.

Turning to the power installation it may well be said that the engine is the heart of an airship, for upon its reliability the life of the ship, if not of its passengers and crew, may be said to depend. Very great attention has therefore recently been given to the development of an engine which shall combine the reliability of the marine steam engine, with the lightness of an aeronautical engine. In order to eliminate fire risk it has been necessary to abandon entirely the use of low flash point fuels such as petrol, and experiments have been concentrated on engines designed to use oils of such high flash point as to place them outside the danger zone when operating in tropical areas.

At present endeavours are being made on behalf of the Government to produce an aeronautical engine on the Diesel or semi-Diesel principle, but it is open to doubt whether an engine working on a high temperature cycle and of light weight can be rendered absolutely reliable and free from the possibility of mechanical breakdown when operating under commercial conditions, without some years of trial and experiment. The attempt to produce an engine on these lines involves a very large reduction in weight, for a reliable type of Diesel commercial engine would not be considered heavy at a weight of, say, 120 lb. per brake horse-power, while for an aeronautical petrol engine 2 lb. per brake horse-power is common, and the limit for a successful airship type engine might be put at 5 lb. per brake horse-power dry.

These considerations led Commander Burney, when formulating his now well-known scheme for the development of commercial airships, to investigate the possibilities of an engine burning a medium but safe type of fuel oil in conjunction with hydrogen; for it had been shown in 1920 by Mr. H. Ricardo that the introduction of a certain proportion of hydrogen into the cylinder of an engine burning kerosene, or a similar oil, produced a marked

* From a paper by B. N. Wallis, B.Sc., of the Airship Guarantee Company, read on February 10th before Lloyd's Register Staff Association.



LAUNCH OF H.M. ARMOURED CRUISER SUFFOLK

improvement in the smoothness and economy of running, and also resulted in considerably lowering, without loss of thermo-dynamic efficiency, the temperature cycle on which the engine operated.

Experiments are now proceeding with a 600 brake horse-power engine of this type, and the results obtained so far justify the highest expectations, although it is but natural that some initial difficulties should be experienced. This engine, although weighing only 5 lb. per brake horse-power, has been designed by Mr. Ricardo on almost marine lines, and the final type, the designs of which are well in hand, is actually fitted with a link reversing movement, enabling us to dispense with all gearing and clutches in the transmission system.

The full advantages of the hydrogen-kerosene engine are worth some further explanation. During the course of a long voyage, an airship owing to the consumption of fuel and oil, becomes progressively and ultimately uncomfortably light, and at intervals of, say, twelve hours, it becomes necessary to discharge corresponding volumes of hydrogen, in order to counter her tendency to rise. On arrival at her destination, subject to any pronounced change in atmospheric conditions, a total volume of gas equal in buoyancy to the weight of fuel consumed, will have been discharged uselessly into the air. On a voyage, say, from London to Cairo—2200 miles—this gas would represent a loss of between £200 and £300, according to the current cost of production of hydrogen reckoned on a commercial basis; though at the prices ruling at present the sum might be three or four times as great.

Several schemes have been put forward to meet this difficulty, the principal being to put the ship in ballast by recovering water from the products of combustion contained in the exhaust gases of the engines. Theoretically it is chemically possible to recover some 150 per cent. of the actual weight of hydrocarbon fuel burnt, but water recovery plants in practice become far too bulky and heavy for airship work if the degree of recovery is carried much beyond 75 or 80 per cent. Thus the loss of gas is not wholly avoided and, further, the system of recovery of water from exhaust gases, though at first sight an attractive proposition, is accompanied by certain grave, and, in the opinion of many, actually dangerous disadvantages.

On the other hand, on the hydrogen-kerosene system we have produced an engine which, instead of burning about ·5 lb. of highly volatile and inflammable petrol per horse-power hour, works on a mixture of but ·38 lb. kerosene and ·024 lb. hydrogen per horse-power hour. By this means the danger of fire has been entirely eliminated, the maximum range of the ship is increased by 30 per cent., wastage of hydrogen is cut out, and navigation is simplified.

Many interesting features have been introduced into the machinery installations of rigid airships, owing to the peculiar conditions under which we have to work. For instance, when working at or near ground level full sized radiators for engine cooling water, and for the lubricating oil circulation system are required; but when at a good altitude, particularly if an engine is stopped, it is necessary to withdraw the water radiators entirely into the warmth of the engine car, while the oil cooler is by-passed, and warm water is circulated through a special heating coil in the oil tanks to prevent the oil from becoming too viscous to be pumped.

Main supplies of fuel and oil are carried in a series of small tanks usually of about 1 ton capacity each, distributed in suitable positions in the structure of the ship. As many as thirty of these tanks may be carried and all are inter-connected to a supply and distribution pipe system.

The engine telegraphs afford a further interesting problem, the synchronism of instruments situated perhaps 500ft. apart employing light-weight materials for the transmission system, being no easy matter, particularly when the electric type of telegraph is barred owing to its liability to fail at critical moments.

The physiological simile suggested for the engine may be further applied to the control station of an airship; for if the engine is the heart, the control station is the brain from which all orders are dispatched. Here in a small space, perhaps 8ft. square, are situated all the mechanisms for the control and operation of the ship, including wireless cabin, telephone exchange with perhaps as many as twenty or thirty extensions, rudder and elevator controls and tell tales, engine telegraphs, manœuvring gas valve operating gear, ballast controls, mooring controls, bomb sights and release gear, voice pipes, switchboards, signalling apparatus, binnacle and drift indicator, and a whole bulkhead full of uncommon looking instruments that could perhaps only be equalled in number and variety on a large submarine.

With all the instruments that science and ingenuity can produce, however, the pilotage and navigation of an airship must necessarily present many complexities, for the conditions encountered on a long flight are variable and sometimes difficult to determine. Buoyancy, height, ground speed and course made good are perhaps the most difficult and certainly the most important things a pilot wants to know.

Buoyancy is affected by atmospheric conditions, and in England varies about 6 per cent. on either side of the mean at any given level, according to the pressure, temperature, and humidity of the air. Since the density of the air decreases with increase of altitude and the material of an airship's gas-container cannot be made strong enough for reasons of weight to withstand any but trifling pressures, the gas must be allowed to adjust its pressure automatically to approximately that of the atmosphere. Provided that the bags are not full, expansion can take place within the limits of the gas space available, but once this space is completely filled, gas must be discharged through large automatic valves provided for the purpose, and the contained volume of gas thereafter remains constant whatever further decrease in the density of the surrounding air takes place.

When once the constant volume stage or "pressure height," *i.e.*, the height at which the bags come up to pressure and begin to blow off, has been reached, a further decrease in atmospheric density reduces the buoyancy of the ship, and since the deadweight remains constant the vessel will automatically reach an altitude limit or "ceiling" beyond which it is impossible to rise except by:—(1) Reducing the deadweight, *e.g.*, by discharging ballast, &c.; or (2) by dynamic lift, *i.e.*, by flying the ship inclined bow up to the mean flight path. The amount of dynamic lift thus obtainable may be as much as 10 or 12 per cent. of the gross displacement of the vessel, depending on the angle of inclination and the engine power available. A pilot is most unwilling to adopt this device, as gas once lost is gone for good, and static equilibrium can only be regained by discharging weight.

It is, however, of great importance in a commercial service to be able to choose freely one's flying level, as the speed and direction of wind usually varies at different heights. Thus a head wind at 3000ft. may change to a beam wind at 6000ft. and a fair wind at 9000ft., and one may often detect these variations in wind direction from the ground by watching the movements of the clouds. The commercial airship pilot will no doubt become weather wise in choosing his flying level as flying routes become more defined.

Here the hydrogen-burning engine is of great assistance to the pilot, because the gas bags begin to empty directly the flight is begun, and he is very soon in a position to vary height up or down to suit the wind without bothering about change in buoyancy or loss of valuable gas.

The helium-filled ship, on the other hand, is in a sorry state, for with helium at a price some thirty times that of hydrogen not a cubic foot can be wasted, and the helium pilot is in the unfortunate position, first, of having to start with his bags only partially filled, thus reducing the buoyancy of his ship and consequently the quantity of freight and fuel that he can carry; and, secondly, of being unable to rise above the pressure height which the initial partial deflation of his bags enables him to attain without blowing off gas. This restriction constitutes a grave danger, and it is quite possible that it was the inability of the Shenandoah to manœuvre freely that led her commander to risk driving through the low level storm, which proved her destruction, instead of rising to avoid it altogether.

So much publicity, however, has been given to the subject of the use of helium in airships by the Press, that it may not be out of place to quote from an article by Major P. L. Teed, late head of the Hydrogen Section of the Inter-Allied Aeronautical Commission in Berlin and one of the leading authorities on gas production for airships in this country:—

"Though many natural gas discharges in different parts of the world contain appreciable quantities of helium, except perhaps in Canada, there is at present no known source outside the Middle West district of the United States of America, where the total available volume is sufficient for airship requirements. After a very great expenditure—variously estimated at from £500,000 to £1,500,000—a satisfactory type of plant has been developed by the Linde Company in conjunction with officials of the United States Bureaux of Mines and Standards, which, by the total liquefaction of the whole of the gas, except the helium from a natural gas discharge, enables the latter to be separated and ultimately purified until it contains about 97 per cent. helium by volume.

"Naturally such a process, involving as it does the compression of the whole of the gas under treatment to a very high pressure and its subsequent cooling to within the neighbourhood of absolute zero, is exceptionally expensive, and though the cost of helium produced at Fort Worth in the United States is now given at 5 cents a cubic foot, it is thought that if commercial as opposed to Governmental accountancy were adopted, an even higher figure would be recorded."

And with regard to fire risk, he continues: "It is, of course, due to its non-inflammability that helium has been adopted by the United States for the peace time inflation of airships, and it would be idle to contend that hydrogen is in any way comparable with it in this respect. However, while this latter gas is combustible, in a modern suitably designed airship the possibility of its catching fire is so small as to be almost negligible. In order that hydrogen may burn in air, it is essential that at some point its temperature be raised to at least 508 deg. Cent. Thus to obtain a hydrogen fire on an airship hydrogen and air must be mixed together, and in some portion of the mixture the temperature must be above a red heat, a combination which is improbable, for it presupposes a leak of hydrogen and a fire occurring simultaneously in close proximity."

The danger resulting from a hydrogen leak is not very great, for hydrogen weighs less than one-fourteenth as much as air. Therefore such gas as leaks from the bags rushes upwards away from the engines and crew to escape from the top of the airship.

We may briefly summarise the defects of helium as compared with hydrogen as follows:—(1) It reduces the gross lift of the ship 8 per cent.; (2) it reduces the disposable lift 16 per cent.; (3) it reduces the lift available for passengers and freight, after allowance has been made for fuel and stores, &c., 30 per cent.; (4) it reduces the maximum length of full speed flight 40 per cent.; (5) without water recovery the volume of helium consumed is 34 per cent. greater than the volume of hydrogen on a similar ship with a hydrogen-kerosene engine; (6) with water recovery the speed, useful lift, ceiling, and safety of the helium ship are reduced; (7) helium costs thirty times as much as hydrogen, its sources are not distributed over the globe, but are concentrated in one Continent. The cost of its transport at high pressure in heavy steel cylinders to other airship centres would be prohibitive; (8) having regard to improvements in design and ventilation in modern ships, to the introduction of the hydrogen-kerosene engine, and the elimination of petrol thereby, we are definitely of the opinion that hydrogen is no longer a source of danger in an airship, but that helium, by the large reduction it causes in the flight efficiency of the ship, may well be so.

An Automatic Rotary Converter Sub-station.

A COMPLETELY automatic 500-kilowatt rotary converter equipment has been put into operation at the works of Mather and Platt, Ltd., of Manchester. The converter was manufactured in the company's shops, whilst the automatic gear was constructed by A. Reyrolle and Co., Ltd., and the transformer by Ferranti Ltd. All the automatic control gear is entirely metal-clad, and it is designed with a view to employing a small number of relays of a simple type. The main high-tension switch panel, which is shown in Fig. 2, consists of a 6500-volt compound-filled metal-clad panel, with a rupturing capa-

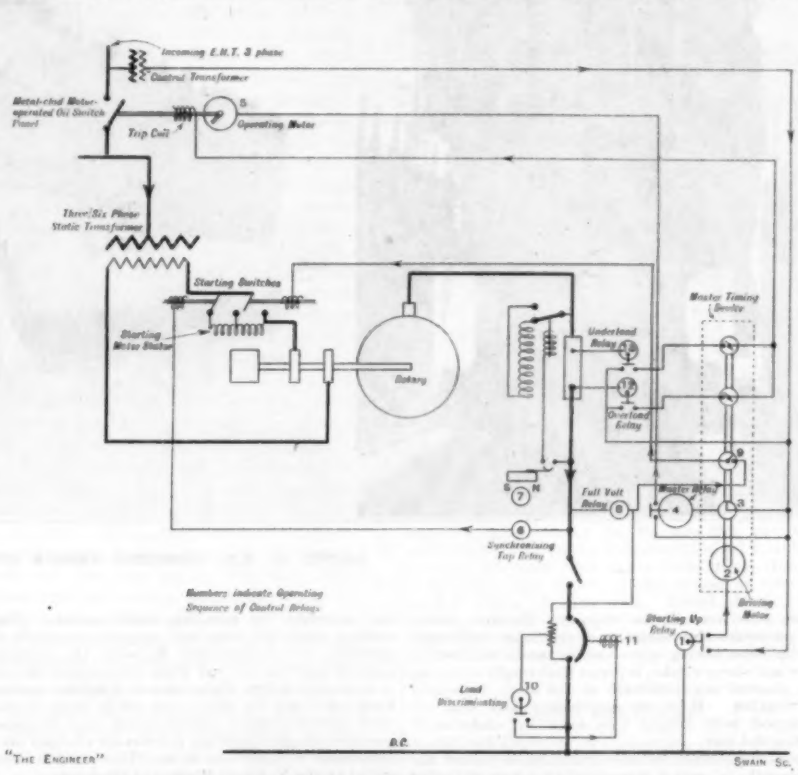


FIG. 1—SIMPLIFIED DIAGRAM OF CONNECTIONS OF AUTOMATIC SUB-STATION

city of 75,000 kilovolt-ampères, and is provided with a three-phase potential transformer on the incoming side, low volt, overload and earth leakage protective gear, with low-tension fuses. A small three-phase motor mounted on the top of the bus-bar chamber—see Fig. 2—serves to control the plant without interfering with the well-known draw-out principle of the Reyrolle gear or without preventing hand operation being adopted, if necessary.

The Ferranti transformer is placed immediately behind this switch—as shown in Fig. 2—whilst the starting switchgear is erected between the transformer and converter—shown in Fig. 3—thus minimising the length of cable required for the low-tension connections between the transformer and the rotary converter slip rings. The starting switchgear differs very materially from that generally used in connection with automatic rotary converter equipments. Instead of the usual air break contactors, three metal-clad oil-immersed Reyrolle 400-volt mining type switch pillars are employed. They are provided with interlocks, and are designed for solenoid operation.

The Mather and Platt patented method of starting, to which we have often alluded, has been adopted, for, on account of its simplicity, it is particularly suitable for

automatic control. The system facilitates synchronising and the control of polarity, and it is unnecessary to lift the direct-current brushes during the starting period. On the direct-current side of the converter—see Fig. 3—a standard three-wire machine switch panel has been provided. It feeds on to the direct-current shop network, and the machine works in parallel with the manually operated equipment in the company's main sub-station, some hundred yards away. The automatic control panels, to be seen in Fig. 3, are mounted alongside the direct-current machine panels. There are two of these automatic panels, on one of which the indicating instruments and manual controls are mounted, whilst the other panel carries the whole of the relays for automatic operation. These relays start up the plant in the event of low voltage on the network or through the agency of an astronomical time switch. A Reyrolle standard master timing device, to be seen in the centre of the lower part of the middle panel in Fig. 3, prevents starting up as the result of momentary voltage kicks, and it energises the closing motor on the high-tension oil switch through the operation of the master relay, indicated in Fig. 1. This cannot occur, however, unless the alternating low-voltage coil is first energised, its circuit being completed, through all the main protective devices and through the auxiliary police switches, indicating the position of the various starting switches and the direct-current circuit breaker.

As the closing motor is a three-phase machine, it will not start with single-phase current, and the gear will not therefore come into operation if the voltage on one of the phases is lost. As a further protection against single-phase operation, however, certain of the alternating-current relays are connected to opposite phases.

The sequence of operation of the various control relays is shown in the diagram, Fig. 1. When the high-tension switch is closed the transformer is energised, and the starting motor of the rotary converter is immediately connected to the low-tension side of the transformer. The machine then begins to accelerate, and when the correct polarity has been determined by a relay, the low-tension transformer connections are transferred to the second or synchronising step, when the machine runs up to full speed, and the main field having been adjusted to the correct synchronising strength, the machine is brought into synchronism. The relay which comes into operation when synchronism has occurred closes the main or running contactor on the low-tension side, cutting out the starting motor, opening the contactors controlling it, and connecting the low-tension transformer directly to the slip rings, whilst at the same time the field strength is adjusted to give normal no-load voltage on the direct current side. The discriminating relays controlling the operation of the main machine circuit breaker are also put into operation. If the load proves to be within the limits of the machine the circuit-breakers close, and the load is at once taken up. Underload and overload direct-current relays govern the operation of the set through the medium of the master timing device, which also embodies in one common case all the time elements for the whole equipment. If for any reason the set should fail to synchronise, the machine automatically shuts down, and will start a second or third time before it finally locks itself out. The time taken for the machine to run up and take over the load is claimed to be considerably under one minute. The exciter and main bearing temperature device and the overspeed device were both designed and manufactured by Mather and Platt, Ltd. At present the polarity of the converter is determined by an exciter, but the makers have recently brought to our notice a new scheme which always gives the correct polarity without the use of an exciter.

A noteworthy feature of the Reyrolle equipment is that each piece of the main apparatus controlling the equipment is not only provided with a handle, but is made for normal hand operation as well as for fully automatic control, thus providing facilities for overhaul and efficient inspection. All the relays are of the plain electro-magnetic type. Their lift and fall armatures carry visible contacts and they are enclosed in dust-tight cases of uniform design with glass fronts. The master timing device constitutes an ingenious adaptation of simple principles, and comprises a single main shaft driven at a speed of approximately three revolutions per minute, and by means of electro-magnetic clutches controlled by the various relays, simple trains of gearing, driving graduated cams are made to operate visible contacts, the range of timing afforded by this piece of apparatus giving ample margin to meet the varying conditions met with in practice.

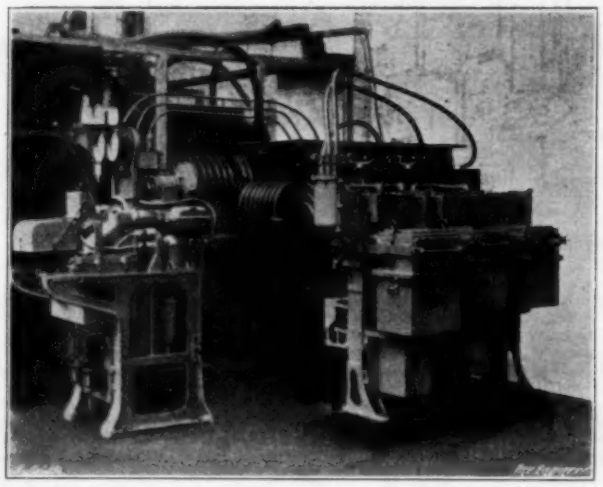


FIG. 2—METAL-CLAD SWITCHES AND TRANSFORMER

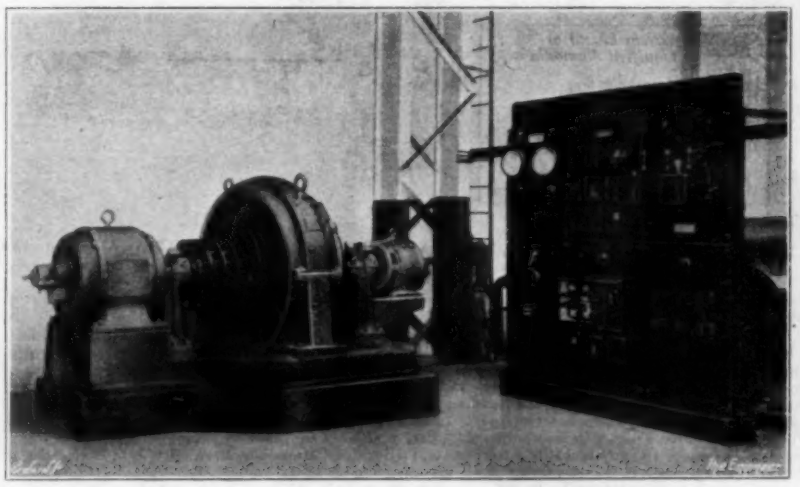


FIG. 3—CONVERTER AND DIRECT-CURRENT SWITCHBOARD

Research and British Engineering Progress.

AT the annual luncheon of the British Electrical and Allied Industries Research Association, the President, Mr. Llewelyn B. Atkinson, delivered an address in responding on behalf of the Electrical Research Association to the toast proposed by the President of the Institution of Electrical Engineers. As it is of great interest to British engineers, and by its infective optimism that what England has done, England can do, we report it practically in full.

The results already obtained by the British Electrical and Allied Industries Research Association for the industry translated into money value vastly exceed the expenditure, and have warranted the carrying on of the Association for a further period of five years, and agreements have been entered into covering the minimum financial requirements, under which the Department of Scientific Research supports the Association, but approximately only to half the extent of its previous support. Let me say that this reduction is not made in consequence of any dissatisfaction with the Association or its work, but as a matter of general policy, and we are advised that at the end of this period the industry must look after itself. As many here to-day are not vitally interested in the details of our work, and in any case this chair is not a suitable place to expound it, I propose to say a few words on the national and Government attitude to research.

It unfortunately is the case that the majority of people of all classes in this country have had educationally no touch with or understanding of the great organised body of knowledge known as science; the majority of young people leave school very inadequately educated in anything, least of all in scientific knowledge, and they dread it and deliberately shun it. The upper classes also in the main are trained or attempted to be trained in history, in ancient classical literature and languages, in modern literature and languages, and commercial subjects, but again very few have any touch with or understanding of science. The business and financial and banking interests are recruited from these classes, and although on specific subjects they employ scientific experts, they have no sort of individual belief in the possibilities arising, if every subject is dealt with on the basis of secure known facts, rather than of words and opinions and individual experience.

It seemed during the war as if they had changed. It was found that the talk of politicians, the strategy and tactics of armies of human beings manœuvring towards, round and through one another—all these had no meaning, and led nowhere, and engineers, scientists, inventors, medical men and the like, the body, indeed, of scientific knowledge, was called upon to come to the rescue.

All kinds of investigations were started, all kinds of research initiated, results almost inconceivable were obtained, but in a year or two after the war was won by these people, the groups who govern, and those who direct our industries, fell back on the old methods and forgot what they had never liked, because they never understood.

And so the Government of this country, a country which in science has towered above all others and made modern existence possible, stands back from research; and whilst it pours out millions into backward industries and desert wastes, fails to comprehend what scientific research in every department of life can achieve. I sometimes wonder how many of our countrymen realise that modern industrial and scientific knowledge is almost wholly the production of British effort. May I for the moment remind you of facts and names? The greatest industries of the world are agriculture, engineering, wool and cotton. English agriculture, despite its financial depression arising from charges and burdens not borne elsewhere, is the highwater mark of the world—nowhere in temperate climates is such production per acre to be found; its breeds of livestock and its seeds, produced either by like breeding or by Mendellian crossing, have no equal, and go all over the world in the effort to reproduce the results of British agriculture. The names of Coke, of Bateson, Gaston Sutton are our witnesses.

In engineering our inventors led the world. Watt made the steam engine a workable machine. Parsons gave the world something which as a steam power producer still has no rival. Whitworth made accurate engineering production possible by his machine tool inventions. Bessemer and Martin made a steel world for us. The steam locomotive and the railway, originating with Trevithick and Stephenson, which have spanned the world are purely of British origin and substantially the iron steam-driven ship is a purely British production. Of electricity and its application, I will speak in a moment. Again, the great woollen and cotton industries which clothe mankind are British inventions. I mention Arkwright, Hargreaves, Crompton, the result of British research and genius, and the initial production of artificial silk is largely attributable to Swinburne and Swan, two British electrical inventors. The coal gas industry, with all its offshoots, is due to Murdoch, another Englishman. If we turn from these great industrial occupations to the sciences more definitely so described, we find the same position. In mathematics, for example, we owe the discovery of the property of certain arithmetic series on which logarithms are based, to Napier, an Englishman, without which discovery astronomy and navigation would be practically impossible. Newton discovered the principle of the calculus of limits on which nearly all modern mathematics is based, and he and another Englishman, Taylor, discovered covering algebraic series which made the principle possible of application. Vector algebra is the invention of two Englishmen, Hamilton and Heaviside.

Navigation, which thus opened the whole world, was made possible by Hadley's sextant and Harrison's chronometer. Optics in its great branches of geometrical optics and physical optics, were entirely founded by Englishmen. Newton discovered the decomposition of light into the spectrum, and was followed by Wollaston, the first who ever observed the dark lines on the solar spectrum, on which spectrum analysis of the materials of the sun and stars is founded—both Englishmen. They were followed by Huggins and Lockyear, who extended and applied this knowledge to the chemical analysis of the universe, to the measurement of star temperatures and star movements. Young, whose brilliant researches proved the undulatory theory of light, was an Englishman. Two Englishmen, Dolland and Gregory, made possible respectively the achromatic lenses, the foundation of all modern optical instruments and the reflecting telescope, an unrivalled instrument of stellar research. If I turn to physiology and medicine, what do we find? Harvey, the discoverer of the circulation of the blood, and Hunter, the first scientific surgeon. The whole of modern surgery based upon Lister's application of Pasteur's discovery of the germ origin of infection, and Davy, who discovered anæsthetics, and Simpson, who applied these inventions to operative surgery, the discovery of vitamines, which is revolutionary in the science of nutrition, due to another Englishman, Hopkins; and if I come almost to the last few weeks, we have the unlocking of the door of the secret of cancer in the discovery by Dr. Gye and Mr. Barnard of the virus of universal presence with a specific factor selective of the species, which will lead to the solution of that baffling problem. Again, it is the triumph of British research. In chemistry, I will only mention one or two names, but they are fundamental. Dalton, the founder of atomic theory in chemistry; Davy, the discoverer of the electrical production of sodium and potassium, the process by which to-day all our aluminium is made; Faraday, who discovered benzole, the foundation of all synthetic organic chemistry and dyestuffs; Perkins, who discovered the aniline dyes from which 90 per cent. of our colours are derived—all English researchers.

May I, finally, turn to electricity? The voltaic battery and the magnetic action of currents of electricity are not British discoveries, but that said we have finished. Electro-magnetic induction, on which the dynamo, the motor, the transformer rest, was due to Faraday; the dynamo itself to Wheatstone, and simultaneously Siemens; the arc light discovered by Davy; the carbon incandescent lamp by Swan; the practical distribution by high pressure by Ferranti; the distribution of power from the great Niagara waterfall decided by a Commission, of whom the majority were English and the method adopted that of an Englishman. If I speak of physics, how little of the fundamental discoveries is left after Newton, Kelvin, Joule. All wireless bases itself on the discovery by Maxwell, by purely mathematical research, that every change of electric or magnetic condition sets a wave in motion that traverses all space until it meets a conductor. That was carried forward by Hertz, Lodge, Marconi. The thermionic valve invented by Fleming, another British contribution to wireless work. The telephone we owe to Graham Bell, an Englishman also. To Crookes, J. J. Thompson, Sir Ernest Rutherford, the last of whom we may claim as English, although I believe an Australian by birth, the world owes our knowledge of the structure

of the atom; to Sir Wm. Bragg, the world owes the interpretation of the structure of crystalline forms built up from these atoms. So of all modern science, what is left? Not a great deal. I do not wish to be ungenerous. Radio-activity, the germ theory of disease, the voltaic cell and electro-magnetism and the internal combustion engine we cannot claim.

Our fundamental discoveries have been carried forward and applied by hundreds of brilliant workers in all lands, but the claim that every great step forward in modern science is a British product, cannot seriously be refuted. Why have I perhaps wearied you with these claims and names? Because I want to say this—that it is unbelievable, unless it be due to ignorance, that any civilised state with such a record, in face of the new world produced in about 150 years by British research, realising, if measured in money, millions upon millions of pounds every year, measured in human population which can be supported many hundredfold increase, should have as its deliberate policy that it will not support research. It is true that the record I have given you is one of individual achievement often under the greatest difficulty that will continue, but modern research needs more costly apparatus and more workers to carry it forward. That is what the Association is now doing. This policy does not arise from the Department of Industrial and Scientific Research; from Sir Frank Heath and his colleagues we have had every help. The problem of employment in this country on the scale necessary to maintain the present population depends wholly on the finding of new products, new methods, new outlets. The problem of removing the present universal discontent and aversion to work and efforts is one that can be solved by research, probably into foods and living conditions. We hear that within a few months the nation is to find £20,000,000 or more to support the most backward industry in the country, a sum which if applied to research would almost certainly enable in a few years the production of coal to be abandoned for ever. Any Government, any industrial leaders, who can fail to see that research by Englishmen can accomplish any and every result, convict themselves of blindness to fact, of lack of logic, of lack of imagination. Research associations and research workers are not asking for charity, they are urging that the present squalid civilisation should be replaced, as it can be, by a far better one, if applied knowledge in every sphere is encouraged and developed; that instead of being a last charge upon the resources of the nation, research should be a first charge. We urge that the Press should make it part of its daily duty to inform its readers in suitable but accurate terms of the advances in knowledge that have been made, and are being made, and of the progress possible and of the immense economic advantages that must accrue, and thus use its influence in creating an atmosphere driving Governments to action. These are the claims of all researchers; we electrical men take our share in pressing the claim.

A New Refrigerator.

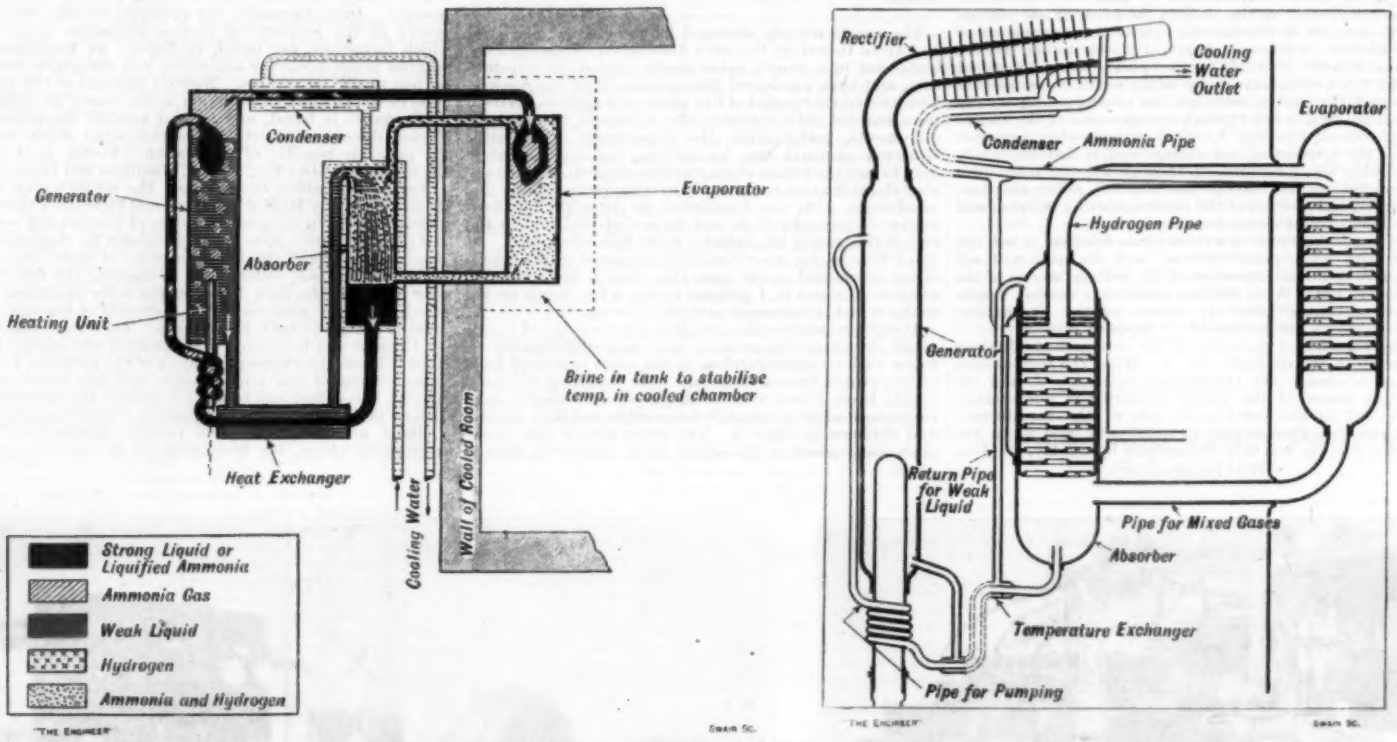
THE refrigerating apparatus which we illustrate herewith is the invention of two young Swedish engineers, Messrs. B. de Platen and C. Munters, and is being manufactured and placed on the market by Electrolux, Ltd., of 153/155, Regent-street, London, W. 1. It works on the ammonia evaporation principle, and is continuous in its action. Its distinguishing feature is the fact that it embodies no moving elements whatsoever, no motor, fan, valve or other mechanical operating device forming part of its construction. For the present the system embodied in the invention is being applied to refrigerating apparatus of a small size suitable for domestic and similar use, such as the preservation of food, but, we understand, its application on a larger basis is only a matter of time. The energy required to operate the apparatus is supplied either by a small gas burner, an electrical heating unit, exhaust steam or other convenient source of heat. As supplied by the makers the apparatus is charged under pressure with distilled water, ammonia and hydrogen, and as all the pipes and vessels are connected by welding, these substances remain in use an indefinitely long time. Beyond the supply of heat nothing farther is required except a circulation of cooling water.

In all continuously operating refrigerating systems there are of necessity a portion of the apparatus under relatively low pressure and another under relatively high pressure. In the ammonia evaporation system the refrigerating effect is produced by the evaporation of the ammonia in the low-pressure part. In the high-pressure portion the ammonia is condensed and the cycle is then repeated. The circulation of the working fluid between the two portions necessarily involves the expenditure of energy, which hitherto has generally been supplied by a motor or other mechanical source of power. Moreover, between the high and the low-pressure portions some form of valve has hitherto been required to effect and regulate the reduction of pressure. In the "Electrolux" refrigerator the circulation is effected on the thermo-syphon principle, while the reducing valve is eliminated by an ingenious application of Dalton's law of gaseous pressures. Dalton's law, it will be recalled, states that the total pressure of a mixture of gases inside a vessel is equal to the sum of the partial pressures of the separate gases; that is to say, the sum of the pressures which the gases in the mixture would exert if they were separately caused to occupy the vessel.

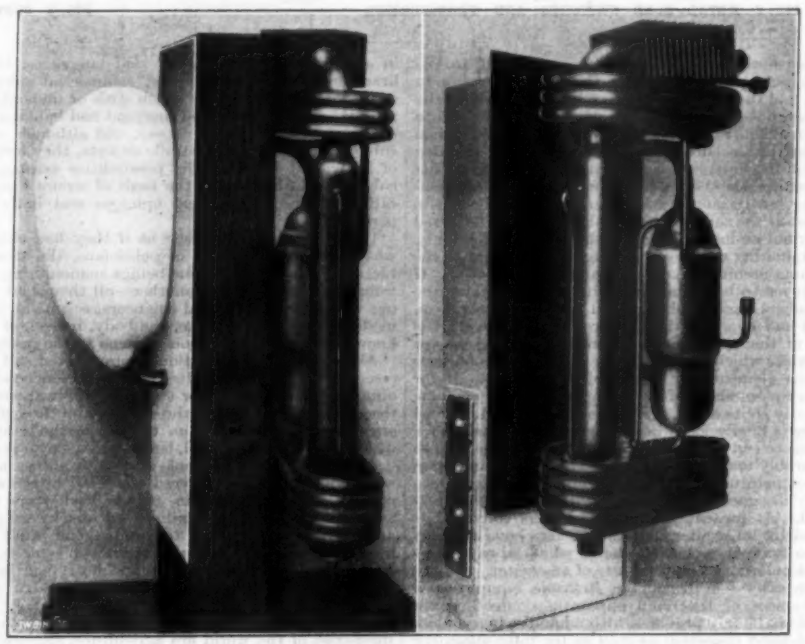
In the "Electrolux" refrigerator the pressure on the ammonia in the high-pressure portion of the apparatus may be of the order of 180 lb. per square inch, while in the low-pressure portion the pressure required to effect evaporation may be 30 lb. or thereabouts. The reduction of pressure is effected by introducing into the low-pressure portion hydrogen in such volume and at such pressure as to give a partial pressure of 150 lb. in the hydrogen and a partial pressure of 30 lb. in the ammonia. The hydrogen is removed from the ammonia before the ammonia circulates back into the high-pressure portion. The effective reduction of pressure on the ammonia, of 180 lb. to 30 lb., is thus secured without the use of anything in the nature of a valve, and the total pressure throughout the apparatus is constant at 180 lb. Other inert gases besides hydrogen might be used, but hydrogen has been chosen because its lightness greatly assists the required circulation. Not only does the introduction of the hydrogen effect the required reduction of effective pressure on the ammonia; the fact that it results in the total pressure being virtually uniform throughout the apparatus reduces the energy required to effect the circulation and indeed makes practicable the use of a simple thermo-syphon system for achieving such circulation.

The apparatus as shown in the diagram—Fig. 1—and in the more complete drawing given in Fig. 2, comprises three chambers, known as the generator, the absorber, and the evaporator. The evaporator is placed inside the chamber to be cooled. The generator is heated by a gas, electric or other unit and, with the absorber, is placed outside the chamber.

Inside the generator there is a mixture of ammonia and water. When this mixture is heated the ammonia



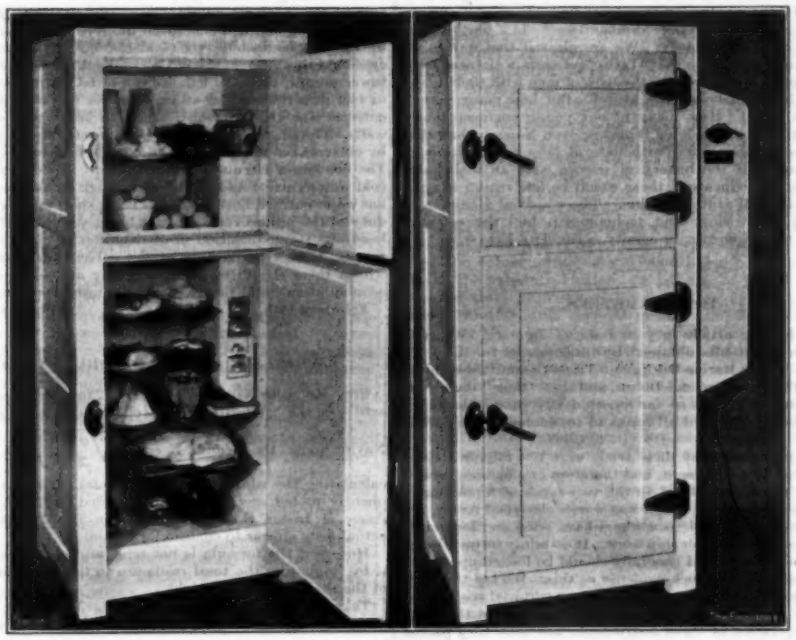
FIGS. 1 AND 2—THE PLATEN-MUNTERS AMMONIA EVAPORATION REFRIGERATING SYSTEM



FIGS. 3 AND 4—THE EVAPORATOR, GENERATOR AND ABSORBER

is driven off and, ascending upwards, passes through a water-cooled condenser in which the gas is liquefied. Any water vapour passing off with the ammonia is condensed in an air-cooled rectifier, which, as indicated in Fig. 2, is so arranged that the condensed water flows back into the generator, and does not mingle with the liquefied ammonia. Reaching the evaporator the liquefied ammonia falls on to a series of baffles on which it evaporates under the partial pressure to which it is subjected, as a result of an inflow of hydrogen into the evaporator from the absorber. In so evaporating the ammonia draws its latent heat from the space surrounding the evaporator, which space may comprise a chamber filled with brine. The hydrogen enters the evaporator at the top. The mixture of ammonia gas and hydrogen, being heavier than the pure hydrogen, falls to the bottom and leaves the evaporator by way of a pipe which conducts it to the absorber. In the absorber it meets a spray of water—actually weakly ammoniacal—which is received from the generator, and which falls over a series of baffles. In this water the ammonia is dissolved. The hydrogen in the mixture being insoluble escapes upwards to the top of the absorber and re-enters the evaporator.

The strong ammoniacal liquid formed in the absorber leaves that vessel by a pipe at the foot and flows through a heat exchanger working on the counter-current principle. In this exchanger the strong liquid flowing from the absorber is heated, and the weak liquid or water flowing to the absorber is cooled. After emerging from the heat exchanger the strong liquid flows through a coil surrounding the heating unit of the generator. The heating of the strong liquid causes the liberation of gas bubbles from it, which lift the liquid upward until it is delivered into the generator at a point near the top of that vessel. The



FIGS. 5 AND 6—PLATEN-MUNTERS SYSTEM APPLIED TO DOMESTIC REFRIGERATOR

inflow of strong liquid into the generator maintains a hydrostatic head sufficient to cause the liquid freed from some or all of its dissolved gas to flow out of the generator through the heat exchanger and into the absorber, where it once again takes up ammonia and becomes strong liquid. The arrangement constitutes a pump operated, without moving parts, by the direct application of heat to the liquid pumped. In order to promote the solution of the ammonia in the weak liquid or water the absorber is provided with a jacket through which the cooling water is passed on its way to the condenser.

In Figs. 3 and 4 we illustrate the operative parts of the refrigerator. In Fig. 3 the snow-clad evaporator is seen on the left of the board representing the insulating wall of the refrigerator chamber. On the right of the wall—as shown best in Fig. 4—are the generator, towards the front, the absorber, towards the rear, the heat exchanger coil at the foot, and the condenser coil and the rectifier at the top. In Figs. 5 and 6 the domestic pattern of the refrigerator is illustrated. It will be observed that the parts occupy but a small space in the interior, and do not project far on the outside. The brine tank surrounding the evaporator inside the refrigerator extends into both the compartments into which the refrigerator is divided. In the lower compartment the tank is furnished with trays, which, when filled with water, enable a supply of pure ice to be obtained. In the remainder of the refrigerator space the temperature maintained is sufficient for the preservation of food stuffs, but is not necessarily below the freezing point. It is understood, however, that if required the temperature preserved in the refrigerator can be arranged to be as low as 1 deg. Fah.

In the electrically heated form of the apparatus, the type which we have inspected, an arrangement is provided whereby, should the supply of cooling water fail, a mercury contact switch comes automatically into action and cuts off the heating current. The consumption of the apparatus as made for domestic use is, we understand, about 3 cubic feet of gas, or ½ Board of Trade unit per hour, and 5 to 6 gallons of water in the same time.

THE Metropolitan District Station at Blackfriars is being improved. One improvement will be a direct entrance from the public subway at that point.

The Khyber Railway.

THE following are the official abstracts of two papers which are to be brought forward for discussion at the Institution of Civil Engineers on February 23rd :—

"THE KHYBER RAILWAY."

By VICTOR BAYLEY, C.I.E., M. Inst. C.E.

The paper describes the construction of 27¼ miles of 5ft. 6in. gauge railway through the Khyber Pass from Jamrud to the Afghan frontier. A brief historical summary is given of the events leading to the decision to use this route for a railway through the mountain barrier between Peshawar and Dakka.

Location.—The maximum gradient from Jamrud to the summit at Landi Kotal is 3 per cent., and from the latter place to the frontier 4 per cent. There are thirty-four tunnels, having an aggregate length of 3 miles, and ninety-two bridges and culverts. Banks and cuttings amount to 3 million cubic yards of earthworks. The railway rises from 1496ft. above sea-level at Jamrud to 3494ft. above sea level at Landi Kotal in a distance of 21 miles, and descends to 2622ft. at Landi Khana in a further distance of 4½ miles. There are four reversing stations, two below the jaws of the Jamrud end of the Pass; one beyond the point where the line passes from the main valley to the Tora Tigga Valley by a tunnel; and the fourth at Landi Khana, 2 miles from the frontier.

Tribal Territory.—The Pass lies outside British India, and is the home of savage and warlike tribes. Though this land is nominally under the care of the Political Agent of the Khyber, there is no law but tribal custom, and human life and property are lightly esteemed. The virility and intelligence of the tribesmen, however, invited the hope that, by tactful handling, they could be led to take part in the work of construction. Although it was anticipated that rates of pay would have to exceed an economic limit, the continued activities of the Political Agent and the engineers resulted in the establishment of such friendly relations with the various tribes that the cost of earthworks and tunnelling compared favourably with that experienced fifteen years previously on the Loi Shilman Railway.

Labour.—Piecework was considered to be the essential basis of bargaining with the tribes, and a system of allotting petty contracts was devised, the contractors being selected by the Political Agent. Unskilled coolie labour was provided by the seasonal influx of coolies from Ningrahar, Mohmand country, and Kashmir; the tribesmen had the sole management of this labour force, and though they opposed any importation of coolies by rail, they were reasonable as to the employment of skilled labour.

Security.—Existing military stations became the headquarters of divisions and subdivisions, the staff being distributed and collected daily by motor lorry. To ensure security on works, the Political Agent devised a successful scheme of enlisting railway khassadars from all sections of the various tribes, who could be trusted to abide honourably by an agreement.

Since the climate is unusually severe, particular attention was paid to sanitation, medical services, and to the provision of as much comfort and recreation as possible.

Plan of Operations.—Importation of all fuel and plant and of most materials was unavoidable. In view of the heaviness of the work, construction by pushing railhead out and carrying out works as railhead approached was impracticable. It was therefore decided to advance railhead rapidly over easy country to Bagiari, to press on with all works up to 1½ mile beyond Landi Kotal, and to start earthworks and minor works beyond that point, but not to advance them rapidly until the arrival of railhead at Landi Kotal.

Water.—A military pumping installation near Landi Kotal was extended to supply nearly all the railway works, while springs served the remainder.

Materials.—Limestone formations encountered were generally irregular and badly fissured, and building stone had to be imported. The limestone, when burnt in continuous kilns with slack coal, gave a quicklime which slaked vigorously. This lime, when mixed with 1 to 1½ parts of finely-crushed brickdust—surkhi—gave a good mortar for minor works. Brick clay was found near Jamrud and Landi Kotal, where kilns were installed and worked by tribal contractors. For works near railhead at Jamrud, sand imported by rail and broken limestone were used as aggregate for concrete. On other parts of the work gravel from the bed of the Khyber nullah was employed for a 4 to 1 Portland cement concrete, which was largely used for important works. Mortar was generally of a 2 to 1 sand and Portland cement mixture, while a 3 to 1 mixture was used for minor works. When sand was unobtainable, a 2 to 1 mixture of surkhi and cement was used, which proved to be of equal strength to a 3 to 1 sand and cement mixture.

Earthworks.—After lengthy trial and bargaining, a fixed schedule of rates was agreed upon with the tribal contractors, ranging from Rs. 20 per 1000 cubic feet for earth to Rs. 120 for limestone, including lift. The average cost of earthworks was Rs. 58 per 1000 cubic feet, or Rs. 70, allowing for overhead charges due to protection, sanitation, and distribution of staff by lorry.

Tunnels.—Roof portions of all tunnels are lined, except in one through hard limestone. Sides are unlined in limestone and hard shale. Brick lining was generally employed, but concrete was used in limestone, when there was no urgency for lining closely to follow excavation. Headings were driven from each end, and, if possible, from intermediate adits, in order to verify the centre line and to explore the nature of the strata. Many shale tunnels were wet; and, since the shale usually lies with steep dip and strike, and since there are numerous faults, pockets are liable to fall out of an apparently solid mass. This tendency, which was apparent from cracks in the hillside above the tunnel, produced a state of longitudinal tension in the tunnel lining which cracked circumferentially near the mouth. The remedy was to build massive portals well clear of the hillside, which served to prevent the lining from being pushed outwards. One tunnel apparently passed through an underground reservoir, and in another successive roof falls resulted in the formation of a shaft leading to the ground surface 70ft. above; the methods of dealing with these problems are described in the paper. Petrol-driven air-compressors were employed with marked success; but, owing to the number of faces in progress at a time, it was not practicable to use mechanical drills throughout the work. There was, however, little to choose between the costs of hand and machine-drilled tunnels. Costs, which are fully dealt with in an appendix, ranged from Rs. 300 to Rs. 788 per linear foot.

Bridges.—The largest bridge consists of four 40ft. spans and one 80ft. span on piers 80ft. high. The main Khyber nullah is crossed seven times by bridges of two or three 40ft. spans. Foundations are carried to below apparent scour level, and the openings are floored with 9in. of concrete, with deep drop walls upstream and downstream. Special consideration was given to forces due to the braking of trains on high bridges—which is likely to be heavy owing to the steep gradients—and in one instance these forces are transmitted from girder to girder, and finally to the solid rock abutment. When the approaches are on banks, there is some uncertainty as to the actual disposal of these forces.

Waterways were calculated by the method evolved by Colonel G. R. Hearn, Assoc. Inst. C.E.,* and passed satisfactorily the exceptional floods of July, 1925, when a rainfall of 3¼in. in two hours was recorded.

Permanent Way.—The rails are 90 lb. per yard British standard section, laid on deodar sleepers up to Landi Kotal and on Lines cast iron sleepers on the 1 in 25 gradient thence to Landi Khana, there being thirteen per 36ft. rail on straights and fourteen on curves. Curves are generally 7 deg., super-elevated 3¼in., and approached by cubic parabola transitions 105ft. long.

Motor Transport.—Twenty 1½-ton pneumatic-tired lorries gave satisfactory service in distributing staff; but 3¼-ton lorries of the same make would not stand the Khyber roads. Twenty steam wagons, of both 5-ton and 6-ton type, carried 23,000 ton-miles per month at an average cost, including repairs, of 15 annas per ton-mile.

"THE SURVEY AND CONSTRUCTION OF THE KHYBER RAILWAY."

By Colonel GORDON RISLEY HEARN, C.I.E., D.S.O., R.E., Assoc. Inst. C.E.

The paper traces briefly the history of various projects to establish railway communication between India and Afghanistan prior to the reconnaissance carried out by the author on the outbreak of the third Afghan War in 1919. The topography of the country is described; and the author compares various projected routes, namely, the Mullagori-Shilman road, the Kabul River route, and the Loi Shilman Valley cut off from the river route, with the Khyber route finally adopted. The first named is considered to be impracticable; and the relative costs of the other routes mentioned are estimated to be 1, 2, and 1 respectively.

Geology.—The geological features of the country are dealt with in some detail, since the author considers that they have not previously been given sufficient attention. The general direction of the strike is east and west, while the dip is to the north at about 40 deg. There are local faults and folds, of which advantage is taken in location. The rock is mainly a thinly stratified, hard, argillaceous shale, which, though treacherous, is able to stand at a steep angle on the northern side of cuttings; and this fact was of importance in choosing the best alignment. Limestone occurs sporadically, and moraines of boulders and clay, and loose flakes and pebbles form highly absorbent stream beds.

Khyber Route.—The nature of the country traversed by the Khyber route is outlined, and the reconnaissance survey is described step by step in considerable detail. An excellent map was available, but only a general estimate of relative heights and distances was possible. A rough survey, therefore, was made with compass and chain along existing roads, with aneroid barometer levels, plane-table intersections, and clinometer observations. In some parts a tacheometer was used. In the preliminary survey considerable use was made of the tacheometer, in conjunction with reduction diagrams. Stations were levelled and check-levelled before the tacheometer was

* "Minutes of Proceedings," Inst. C.E., Vol. CCXVII., p. 267.

set up at them, and during reduction of levels and transfer to plan the plane table was used in the field for contouring a finished sheet. Location was straightforward, though arduous, subtense work and even triangulation being necessary in parts.

Construction.—Work was divided up by "work numbers," and very particular attention was given to the preparation of the construction estimate, expenditure being checked by card index. The drawing-office was designed with special regard to rapidity of output. The design of the works is briefly dealt with, and a few notes are added on its execution.

An Appendix deals with the design of bridge openings which successfully passed the heavy floods of July, 1925.

The organisation, in which strict economy was observed, is described in an Appendix, while a third Appendix tabulates, and gives comments on, the construction plant. The cost was about £60,000 per mile.

THE INSTITUTE OF METALS.

THE annual and extraordinary general meetings of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, on Wednesday and Thursday, March 10th–11th, 1926. The annual general meeting will begin at 10 a.m. on March 10th, and the extraordinary general meeting at 10 a.m. on March 11th. The latter is called for the purpose of passing a resolution to adopt a new set of Articles of Association. On March 10th the annual dinner of the Institute will be held at the Trocadero Restaurant.

The following papers are expected to be submitted :—

(1) R. W. Bailey, "Note on the Softening of Strain-hardened Metals and its Relation to Creep."

(2) Professor C. O. Bannister, "Note on the Corrosion of an Ancient Tin Specimen."

(3) T. B. Crow, "Some Experiments on the Soft-soldering of Copper."

(4) B. S. Evans and H. F. Richards, "Determination of Zinc Oxide in Brass."

(5) W. Feitknecht (Berne, Switzerland), "Crystal Growth in Recrystallised Cold-worked Metals."

(6) R. Genders, "The Interpretation of the Macro-structure of Cast Metals."

(7) Samuel L. Hoyt and T. R. Schermerhorn (Schenectady, N.Y., U.S.A.), "The Hardness of Cold-rolled Copper."

(8) W. Hume-Rothery, "Researches on the Nature, Properties and Conditions of Formation of Intermetallic Compounds with Special Reference to Certain Compounds of Tin.—Parts I.–V."

(9) W. L. Kent, "The Brittle Ranges of Bronze."

(10) A. Glynne Lobley and Douglas Jepson, "The Influence of Gases on Copper at High Temperatures. Part I."

(11) George Mortimer, "The Die-casting of Aluminium Alloys—A Review of Current Methods."

(12) A. J. Murphy, "The Constitution of the Alloys of Silver and Tin."

(13) A. M. Portevin (Paris, France), "Striation Due to Working or to Corrosion in Microscopical Metallography. A Contribution to the study of the Mode of Action of Etching Reagents."

(14) D. Stockdale, "The Copper-rich Aluminium-copper-tin Alloys."

(15) H. J. Tapsell and J. Bradley, "The Mechanical Properties at High Temperatures of an Alloy of Nickel and Copper, with Special Reference to Creep."

The papers will be taken, as far as possible, in the following order :—March 10th, morning, Nos. 11, 7, 1 ; afternoon, Nos. 5, 6, 9, 14 ; March 11th, morning, Nos. 3, 10, 12, 8 ; afternoon, Nos. 15, 4, 2, 13.

New Members and the London Meeting.—A special Council meeting will be held in London on February 24th for the purpose of considering applications for membership. Those applicants for membership whose forms are in the secretary's hands before noon on February 24th will be entitled to take part in all the proceedings at the London meeting. Subscriptions of members elected as a result of the forthcoming ballot cover the extended period ending June 30th, 1927.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE TRAINING OF ENGINEERS.

SIR,—In a recent leading article in THE ENGINEER you advocated a classical education as the best foundation for the training of engineers. Culture, which is as desirable in engineers as it is in any other class of the community, you seemed to think could best be developed in this way. You suggested that the study of modern languages might prove a not unworthy substitute, but it did not seem to occur to you that culture could be acquired through training in the natural sciences. The proposition deserves some consideration.

Is the popular association of culture with the classics well founded ? May it not simply be due to the fact that by force of circumstances the most highly educated men of the past generation had all to go through the classical mill ? I have no grumble with the classics. Much of my time, it is true, has to be spent among boys whose mentality has been dwarfed by over-insistence on Latin grammar ; but that is the fault of the system, and not of the subject. For myself, I prefer Aristotle and Archimedes, Lucretius and Pliny, who guided the scientific thought of their times, in their English translations.

What, after all, is culture ? The primary meaning of the words is tillage, and hence refinement ; but the thing that matters is a right attitude of mind towards learning and art. If you expect to get this by forcing Latin grammar down the reluctant throats of young apprentices, you are woefully mistaken. It is as well to expect to engender a love of engineering by subjecting a boy to a couple of years of cold chiselling. Much may be done through the classics towards broadening the minds of budding engineers, but it certainly must not be on the usual lines of school-boy Latin.

What vexed me about that leader was the tacit assumption that culture could not be acquired through the study of natural science. Which matters the more, I would ask you, the language or the thoughts of all the great philosophers of Greek and Latin times ? Is there not enough of dramatic interest in the lives and work of Galileo, Newton, Laplace, Pasteur and Darwin, not to mention more ancient or more modern names, to give cultural value to the study of science ? To con Cæsar's description of the building of a bridge may lead to more refinement than to study, shall we say, the almost superhuman difficulties which were overcome before the Panama Canal linked two oceans together ; but for the life of me, I cannot see why.

Let not engineers belittle the essential elements of their own profession. It is as easy to err on that side as on the other.

C. L. BRYANT.

Harrow School, February 12th.

[Our correspondent refers, we believe, to a leading article in our issue of November 6th, 1925, in which some remarks made by Sir William Ellis in his presidential address to the Institution of Civil Engineers were reviewed. We trust he has not overlooked the following sentence in that leader : "Whilst some knowledge of Latin and Greek is very desirable, there is fortunately ample material for very liberal cultivation in living languages, and, we are proud to say, as much in our own tongue as any other." We hope we do not do our correspondent an injustice in thinking that he takes the narrow and departing interpretation of a "classical" education. No one, least of all ourselves, desires to see the classical curriculum of Keate's Eton revived. There is a larger view of "classical" which includes all the literature and art of the world, and, we will add, its science as well. The defect of our present system of education of engineers is that it cuts out all those things that make for the graciousness of life, and considers only those that are held to be useful. We agree with our correspondent, indeed we have often expressed the view in these pages, that science is a part of a liberal education, but experience is proving that it can never be the whole, and that to make men, as well as engineers, we must combine the "humanities"—in a new dress—with science and technology. We are pleased that our correspondent has referrred to the "Lives" of certain eminent men. If in his teaching he combines the lives of men with their works he will go far to make science liberal. But how many schoolmasters do that ? How many of our young engineers know more about Ohm or Boyle or Henry or even Newton than that they are names associated with natural laws or standards of measurement ? If the history of science were an inalienable part of scientific education, there would be less reason to complain of its small cultural value. The essential elements of engineering are science and technology ; but the essential element of the engineer is humanity.—ED. THE E.]

TORSIONMETERS.

SIR,—A leading article in your issue of January 15th comments upon the results obtained by torsionmeter on the trials carried out by the Marine Oil Engine Trials Committee with the engines of the Sycamore and Dolius, and states that "the results of the Committee's trials so far reported have undoubtedly led many engineers to regard all forms of torsionmeter with grave suspicion."

May we point out that these trials were not intended to be tests of torsion measurement, and therefore any opinion formed from them must be confined to the two types of torsionmeter which were used, one of which was a new electrical meter, not unlike types which previous workers have tried and long since discarded as unsuitable for ship work. It certainly seems strange that torsion measurement generally should be looked upon with "grave suspicion" on such evidence as this. We are therefore glad to note the modifying phrase in your editorial reading :—"It is only just, however, to emphasise the fact that the Committee's experience of these instruments has been very partial and that several promising forms of new or improved torsionmeters are in existence which have not been used in these tests."

Reference to an article in your issue of November 20th, 1925, and to one in *Engineering*, March 20th, 1925, will convince that not only is correct torsion measurement possible, but that it has been carried out as part of regular trial-trip procedure for many years by such a firm as Messrs. Wm. Denny and Brothers. There are tables in those articles compiled from results of trials extending over many years and giving a comparison of shaft horse-powers obtained by torsionmeter with those deduced from model reproductions of the trial conditions in the experimental tank. This table, which has been published in other places, if read in conjunction with the explanatory notes, should be a complete answer to criticisms condemning torsionmeters as a whole.

Torsionmeter investigations were commenced when the first commercial turbine steamer was built in 1900, and the development and evolution of the instrument, including the Denny-Edgecombe pattern—with which we have been associated since 1913—has been continuous since that date. The latest form of Denny-Edgecombe meter is purely mechanical in its operation, and embodies an optical principle, by means of which torsional movement at any part of the cycle of revolution may be directly read from the revolving scale.

The question which the torsionmeter is asked to answer is purely a mechanical one, not electrical, namely, "What is the twist in a given length of shaft ?" Where electrical devices are introduced, they serve merely as "means to an end" ; they are not essential to the solution of the problem.

As the result of many years of every-day acquaintance with the problem in its most practical form, this consideration forced itself upon the minds of the designers of the Denny-Edgecombe meter, with the result that the electrical means to an end was departed from in favour of a straightforward mechanical solution, and, in the light of experience over a quarter of a century, a return to electrical measurement can only be regarded, in our opinion, as a retrograde step.

We take this opportunity of reminding your readers that the torsion of the shafts of the oil-engined tanker Scottish Borderer was measured by a Denny-Edgecombe meter specially arranged for direct vision, and also for electrical reading. The results were not only in agreement, but they were consistent with the mechanical efficiency obtained on the test bed, and, further, after the ship's trials the exact conditions were reproduced in the experimental tank with a ship model 12ft. in length, and further agreement to within 1 per cent. was registered, a striking confirmation of the correctness of the torsionmeter.

In view of facts like these, we feel justified in asking for the opportunity of referring to the article above mentioned, and of pointing out that there are torsionmeters obtainable which are out of the experimental stage, and can be relied upon to give accurate results, with either turbines or reciprocating engines, and which are simple enough to be operable by any mechanical engineer of average ability.

KELVIN, BOTTOMLEY AND BAIRD, Ltd.

Glasgow, February 16th.

POWER STATION DESIGN.

SIR,—In the design of modern super-power stations large ground area is required for coal storage, and often further large area for condensing water cooling towers. Coal storage space should be adjacent to the boiler-house and compactly laid out ; water cooling towers should be so arranged that all sides are exposed to unshielded winds. The development of this idea has led me to sketch out a power station enclosed within a ring of cooling towers, containing besides the power station with its attendant buildings also the coal pile, passages through the ring being left for access to the turbine-house, for coal transport, and cable transmission lines. With this design the maximum exposure of the cooling tower walls to the atmosphere is obtained.

A ring of towers arranged as described will operate with various degrees of efficiency on its circumference, depending upon the wind direction ; therefore provision should be made for the maximum use of that portion of the ring during the whole period of its superior efficiency irrespective of the power units carrying the station load. Such a result could be obtained by building two ring water culverts within the ring of cooling towers, the first nearest to the towers to receive the re-cooled water from the towers, and the second the heated water discharged from the condensers. At regular spaces over the hot water culvert would be placed motor-driven centrifugal pumps, each serving, say, three towers, the cooled water pouring on to the floor under the towers and eventually into the cold water culvert. There need be no tank under the towers, the culverts alone forming the water reservoirs. The pumps would be connected into a ring water discharge main so proportioned as to render interchangeable in tower service adjacent sets. To prevent the hot water culvert being emptied should no interchange of water between the culverts be made by the condenser circulating water pumps, or should this interchange not correspond to that effected by the tower pumps, then the balance would be maintained by a flow in one direction or the other over the wall dividing the two culverts, the crest of which would be below that of the outer walls. The ring culverts would be connected to the power-house by culverts running parallel and outside the turbine-house wall. The condenser circulating water pumps would draw from the cold water culvert and discharge through its condenser into the hot water culvert, both pipe lines being short and direct, and the duty of the pumps constant, not being varied by differences in head due to modification in distribution to different groups of towers. The cross section of the culverts or depth of water within them should be such that they are self-scouring ; dirt accumulation could then be trapped at any convenient point.

February 16th. A. L. MASTERMAN.

WHIRLING SPEEDS OF DRUM ROTORS.

SIR,—In your issue of January 22nd there appeared an article on the "Whirling Speeds of Drum Rotors," in which Mr. Naylor quotes the formula $N = \frac{30}{\pi}\sqrt{g\frac{\Sigma W y}{\Sigma W y^2}}$ as a means of calculating the whirling speeds of shafts. This formula is frequently quoted, and from results recorded by Mr. W. M. Wallace, Assoc. M. Inst. C.E., and published in THE ENGINEER (1916), actual tests appear to confirm its reliability.

However, the formula is not true, and an attempt to prove it by "equating the total resilience to the total kinetic energy of the shaft" cannot be right.

Take a single weight W on the shaft. When it is "whirling" at a radius y, then the force which is applied to the shaft and which bends it is $\frac{W}{g}\omega^2 y$. Now let y^1 be the deflection due to the static weight of W, so that we have—

When the deflection is y^1, the load is W,

" " y, " " $\frac{y}{y^1}$ W.

But we have seen that when the force is $\frac{W}{g}\omega^2 y$, the deflection is y.

$$\therefore \frac{W}{g}\omega^2 y = \frac{y}{y^1}W.$$

$$\therefore \omega^2 = g\frac{W}{W y^1} = g\frac{W y^1}{W(y^1)^2},$$

which is, of course, the formula quoted and is true for this case only. We cannot extend it to the case of a number of weights on the shaft for $\frac{y_2}{y_2{}^1}$ will not be equal to $\frac{y_1}{y_1{}^1}$. If this equality is assumed, we get the approximate result as above, which I have said is not true.

P. FEARN, B.Sc. (Eng.).

February 13th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

IT is announced that Mr. O. G. Babington, M.A.I. (Dub.), A.M. Inst. C.E., has joined the board of directors of the Harvie Corporation, Ltd., of Broadway Buildings, Westminster, S.W. 1.

WALLIS-JONES AND DENT ask us to announce that they have removed their offices from 50, Queen Anne's-gate, Westminster, S.W. 1, to 9, Old Queen-street, Westminster, S.W. 1. Their telephone number will remain as at present, i.e., Victoria 8070.

WE are asked to state that Mr. L. J. Serin, M.R. San. I., has withdrawn from sanitary contracting work on the Continent and is now engaged in consulting practice under the style and title of Messrs. Serin and Son, of 30, Rue Alphonse Renard, Ixelles, Brussels, experts specialising in sanitary and sewage installations.

ACCORDING to a report on the working of the Indian Boilers Act in 1923, although that Act requires every boiler in the country to be inspected once a year, only 2369 out of 3010 boilers were actually inspected. The reason given is shortage of staff.

Hydro-Electric Progress in Canada During 1925.

HYDRO-ELECTRIC and water power development in Canada reached record proportions during the year 1925, the increase in the total installation far exceeding that of any previous year. This fact is indicated by the review of the year's activities prepared by the Dominion Water Power and Reclamation Service of the Department of the Interior, the records of which show that 719,000 horse-power were added during the year, bringing the total installation in the Dominion to 4,290,000 horse-power. Many projects are also under way, which will add more than 250,000 horse-power in the early part of this year.

Not only was 1925 of outstanding interest on account of the large increase in installed capacity, but it marked the bringing into operation or completion of a number of large projects which have been under active construction for the past few years. Of them the most notable are the Queenston development of the Ontario Hydro-electric Power Commission on the Niagara River with 500,000 horse-power completely installed, and the development of the Duke-Price Power Company on the Saguenay River in Quebec, which brought into operation 360,000 horse-power of an ultimate capacity of 540,000 horse-power. While the next year or two are not expected to witness as large increases as 1925, there are projects of great magnitude now under way or in early prospect, which will provide substantial additions as they are brought into operation. They include the 800,000 horse-power development recently commenced at Chute à Caron on the Saguenay River by the Aluminium Corporation of Canada, and a project of almost the same ultimate proportions on the Bridge River in B.C. by the British Columbia Electric Railway Company. Numerous other developments of lesser capacity have either been commenced or are in early prospect, so that there is every assurance that the average growth of the past few years will be well maintained in the future.

The widespread nature of the 1925 activities is disclosed in the following paragraphs which outline the developments by provinces. Quebec led with a total installation of 438,300 horse-power, largely contributed by the development of the Duke-Price Power Company, Ontario, followed with almost 200,000 horse-power contributed chiefly by the Queenston development of the Ontario Hydro-electric Power Commission. Other provinces having important additions were British Columbia, with 58,984 horse-power, and Manitoba, with 21,900 horse-power.

BRITISH COLUMBIA.

The 58,984 horse-power net addition to British Columbia's total during 1925 was contributed by two developments, the Stave Falls plant of the British Columbia Electric Railway Company and the Lower Bonnington Falls plant of the West Kootenay Light and Power Company. At Stave Falls on the Stave River the British Columbia Electric Railway Company brought to completion work begun in 1922, which involved the trebling of the storage capacity in Stave Lake both by the raising of the lake level 22ft. by new dam construction, and by diverting the waters of Alouette Lake into Stave Lake by the construction of a tunnel. Owing to the increase in head and the additional water supply, a fifth unit of 15,000 horse-power was added to the plant during 1925, and the other four units raised to the same capacity, which necessitated the rewinding of the existing generators. The net increase in capacity amounted to 23,000 horse-power. Good progress was made by the same company in the work under way at Alouette Lake. The dam at the outlet of the lake and the tunnel 3550ft. long leading the waters to Stave Lake were completed during the year. It is expected that the power station at the Stave Lake end of the tunnel, with an installation of 12,500 horse-power, will be completed during this year.

At Lower Bonnington Falls on the Kootenay River the West Kootenay Light and Power Company replaced its old plant of 4016 horse-power with an entirely new development. Two units of 20,000 horse-power each were brought into operation on July 1st, 1925, and a third unit of similar capacity will be added during 1926. The company is also re-winding two of the generators in its Upper Bonnington Falls plant to secure increased power capacity. The Powell River Company completed the raising of its storage dam on Powell River during the early part of the year, and work is in progress on the construction of a 14ft. diameter penstock which will supply three new units of a total capacity of 25,860 horse power. These units, it is anticipated, will be in operation early this year.

Of developments in prospect the most important is that of the British Columbia Electric Railway Company on Bridge River. This company during the year exercised its option for the purchase of all the shares of the Bridge River Power Company, and has drawn up a programme of development starting probably in 1927. It is expected that the development will be accomplished in successive stages commencing with an initial installation of 54,000 horse-power and reaching ultimately a total of from 550,000 to 700,000 horse-power.

MANITOBA.

The increase of 21,900 horse-power in Manitoba's total during 1925 was entirely in the Point du Bois plant of the City of Winnipeg on the Winnipeg River. Three units of 7300 horse-power were added during the year, and contracts were awarded for two further units of the same capacity for delivery in 1926. These last units will bring the Point du Bois plant to its full capacity of approximately 104,000 horse-power.

The Manitoba Power Company has entered into a contract to supply power to the Manitoba Pulp and Paper Company's mill now being built at Fort Alexander at the mouth of the Winnipeg River. The Manitoba Power Company has a development of 56,000 horse-power present capacity at Great Falls on the Winnipeg River, and, it is reported, will immediately enlarge it by the addition of a third unit of 28,000 horse-power and later by a fourth unit of the same capacity.

The Manitoba Power Commission which purchases power and distributes it in the southern part of the province, was active during the year in extending its lines. These extensions include lines from Jordan West to Miami, from Carman East to Sperling, and from Roland East to Myrtle, amounting in all to 35 miles.

ONTARIO.

The total increase in the Ontario installation was 199,750 horse-power during 1925. While this increase was chiefly accounted for by developments of the Ontario Hydro-electric Power Commission, there were other developments by private organisations of notable importance. The Ontario Hydro-electric Power Commission added two units of 55,000 horse-power each to its Queenston plant on the Niagara River, thus bringing this, the largest completed development in the Dominion, to a capacity of nine units and 500,000 horse-power, with the possibility of the addition later of a tenth unit. In the Western part of the province the Commission added two units of 12,500 horse-power to its Cameron Falls plant on the Nipigon River, thus bringing this development to its full capacity of 75,000 horse-power. For the benefit of the same plant a dam at Virgin Falls was completed, which will provide for complete regulation of the discharge from Lake Nipigon.

In the Georgian Bay system the Commission completed the reconstruction of the South Falls plant on the South Muskoka River, increasing its capacity by 3750 horse-power. A short distance above South Falls a new plant of 1800 horse-power capacity is being constructed at Hanna Chute, which is expected to be ready for operation about March next. For the further supply of this territory detailed field investigations were made of the power possibilities on the Musquash or Lower Muskoka River. For the supply of the Central Ontario system a new development of 4800 horse-power capacity was completed during the month of May at Dam 9 on the Trent Canal below Campbellford, this plant being operated by remote control from the Ranney Falls Station a few miles distant.

The Commission also continued its investigations of further sources of power on other rivers of the province, notably the possibilities on the Ottawa and St. Lawrence Rivers. Among the activities of private organisations, the Abitibi Power and Paper Company acquired the 24,000 horse-power development at Island Falls on the Abitibi River from the Hollinger Consolidated Gold Mines, and added 24,000 horse-power to its capacity during the year, the power being transmitted to the company's mills at Iroquois Falls. The same company added a 6000 horse-power unit to its development at Twin Falls on the Upper Abitibi River. In the extreme westerly part of the province, the Keewatin Power Company substantially completed the construction of a 17,000 horse-power development at the Western Outlet of the Lake of the Woods, at the same time improving the discharge capacity of the Western Outlet and reconstructing the Norman Dam. The power thus provided will be used by the pulp and paper mills at Kenora. In the Sudbury district the Wahnapitae Power Company completed a new development of 7000 horse-power on the Wanapitei River. On Manitoulin Island a new plant of 1750 horse-power capacity was built on the Kagawong River for the Manitoulin Pulp Company. Two developments are under construction by the Quinte and Trent Valley Power Company, which it is expected will be completed early in 1926. The first is at Campbellford on the Trent River, where 1100 horse-power is being installed, and the second at Frankford on the same river, with an installation of 2980 horse-power.

QUEBEC.

As has already been stated 1925 was a record year in water power development in Quebec province, with new installations totalling to 439,000 horse-power. This increase was largely accounted for by the bringing into operation of a development of the Duke-Price Power Company on the Saguenay River, with an initial installation of 360,000 horse-power. Work is proceeding on the extension of the plant, which it is expected will raise the total to 480,000 horse-power by February, 1926. The energy from this development is to be supplied to various pulp and paper mills of the district, and temporarily to the proposed reduction plant of the Aluminium Corporation of Canada.

In the Eastern townships the Southern Canada Power Company completed the installation of a 37,800 horse-power plant at Hemming Falls on the St. François River, while the 12,000 horse-power extension of the company's Drummondville plant on the same river is expected to be ready before the close of the year. Both these developments supply the company's extensive transmission line system in this industrial portion of the province, additional lines having also been completed during the year. In the south-western part of the province the Ottawa River Power Company brought into operation its plant at Bryson on the Ottawa River, with an initial installation of 25,000 horse-power, the ultimate designed capacity being 75,000 horse-power. The energy is transmitted to Ottawa, Hull and district. The Chicoutimi Electric Company's 3500 horse-power plant at Garneau Fall on the Chicoutimi River was also placed in operation during the past summer.

Two other hydro-electric undertakings are well advanced and are expected to be placed in operation in the near future. The largest of these is the Shawinigan Water and Power Company plant on the Batiscan River at St. Narcisse, which will probably be completed by July next. The plant is to have an initial installation of 22,800 horse-power and an ultimate capacity of 45,600 horse-power in units of 11,400 horse-power each, and will be used to supply additional energy to the company's system. North of Ottawa, the Gatineau River Power Company expects to complete the extension of its plant on the Gatineau River near Maniwaki, by February, 1926. The plant will have an installation of 2500 horse-power with provision for an ultimate 3756 horse-power to supply a transmission system extending to Gracefield.

Of construction recently started, the largest power project of the province has been commenced at Chute à Caron on the Saguenay River. This has been undertaken by the Aluminium Corporation of Canada to supply its new reduction works, and an installation of some 800,000 horse-power has been proposed in this connection. An important project for the International Paper Company, on which construction has also just started, is to include a power development of considerable magnitude at Chelsea on the Gatineau River, and a pulp and paper mill a few miles distant near East Templeton.

Other developments and extensions on which preliminary construction was started during the year include the 2500 horse-power Canada Paper Company's plant at Ulverton Rapid on the St. François River; the improvements to the Montreal Cotton Company's plant at Valleyfield to secure an output of 12,000 horse-power, the company also having in view a 5000 horse-power extension later on; the preliminary work started by the Shawinigan Water and Power Company in connection with rebuilding a hydro-electric plant on the St. Anne Parade River at St. Alban, the probable installation to be 4000 horse-power.

Among more or less definite projects being considered by various organisations may be mentioned a water power development by the Ontario Paper Company for pump mill operation on the Manicouagan River on the North shore of the St. Lawrence opposite Metis, the whole or partial development of Chats Falls on the Ottawa River by the Kingdon Mining Company; a development on the Coaticook River by the town of Coaticook; a possible 100 horse-power development on Du Loup River by the Kamouraska Hydro-electric, Limited; a contemplated development of moderate size on Chiens River near Quebec by the Montmorency Power Company, involving a head of some 800ft., one of the highest in Eastern Canada.

The excellent work of the Quebec Streams Commission has continued to benefit greatly and encourage the development of water power in the province. In addition to the operation of extensive storage reservoirs on the St. Maurice, St. François and Ste. Anne de Beaupré Rivers, the Commission completed and brought into operation two additional reservoirs of importance, and pursued extensive surveys and studies of further storage projects and power sites. The Kenogami Lake Reservoir controlled by the Taschereau Dam was completed, and the full storage of 13 thousand millions cubic feet is being utilised to regulate the Sables and Chicoutimi Rivers. The Metis Reservoir of 2¼ thousand million cubic feet capacity was also completed, and is being operated to regulate the flow of the river of the same name. Storage reservoir surveys and studies by the Commission include lakes Baskatong and Kabonga on the Upper Gatineau, a detail survey of Mekinac Lake project on the St. Maurice, surveys of Tremblant Lake on a lower tributary of Rouge River, and of Morin Lake on Fourchue River, an upper tributary of Du Loup River, Temiscouata County. The Commission also carried out a survey of possible power sites in the Upper Ottawa basin up to lake Victoria, and has under study a proposed dam and flood prevention works on Bras River tributary of Gouffre River at Baie St. Paul.

MARITIME PROVINCES.

With the exception of a small installation of 245 horse-power in the Annapolis plant in Nova Scotia, no actual hydro-electric construction was carried out in the Maritime Provinces during 1925. A number of projects is, however, in active prospect. In New Brunswick the matter of the best policy to adopt in connection with the development of Grand Falls on the St. John River is occupying the attention of the provincial government. International difficulties in the way of developing this site were adjusted at a hearing held by the International Joint Commission early in the year. On the Nipisiguit River the Bathurst Company has plans under way for a storage dam on Nipisiguit Lakes to increase the dependable water supply at the company's plant at Great Falls. In Nova Scotia the Nova Scotia Power Commission proposes to construct a storage dam at the foot of Lochaber Stillwater on East River Sheet Harbour, in order to meet the request of the A.P.W. Company for additional power. It is also proposed to increase the capacity of the Commission's St. Margaret's Bay plant by diverting the run-off from 12 square miles of drainage from the head waters of the Sackville River. The Scott Tissue Company is endeavouring to discover a suitable site in Nova Scotia for a small pulp and paper mill requiring an initial installation of 1750 horse-power with a further 1000 horse-power later. The Cochrane Hill Gold Mines have applied for permission under the Nova Scotia Water Act, to develop from 100 to 200 horse-power on McKeen's Brook for gold mining purposes.

Plans are in course of preparation for a pulp and paper enterprise on the Mersey River at Liverpool, N.S., based upon the very considerable water power and timber resources available. United States interests are also seeking about 4000 horse-power on the Liscomb River for pulp grinding. A rural distribution system some 20 miles in length is in course of construction to supply the small communities of Brooklyn, Newport, Newport Station, St. Croix and Ellershouse, for which energy will be secured from the Avon River Power Company.

Boiler Water Conditioning.*

By Dr. R. E. HALL.

WHEN the criterion for control of scale prevention on the evaporating surfaces is made the conditions in the concentrated boiler water, then this control becomes an exact operation, amenable to an accuracy commensurate with all other operations in the boiler-room. The responsibility in boiler water conditioning, however includes more than clean surfaces. Corrosion in feed lines, economisers and the boiler is a function of the condition of the water, and must be controlled. Steam line and turbine blading deposits must be obviated by the system of conditioning. By the chemical treatment employed, the amount and character of non-condensable gases in the steam must be controlled in accordance with the intended use of the steam. All in all, the responsibility in boiler water conditioning ends not with the entrance of the water into the boiler, but with the passage from the boiler nozzle of steam, the dryness and purity of which are defined by the uses to be made thereof.

A clearer conception of the scope of boiler water conditioning can be obtained by reference to the accompany-

* Abstract of paper presented at Mid-West Power Conference, Chicago, Ill., January 27th, 1926. Issued by the Bureau of Mines, Washington.

ing diagram of the surfaces at which it functions. Consideration of this diagram leads to the following outline for the problems of boiler water conditioning :—

(*a*) Prevention of scale formation on surfaces (1) in contact with water but at which no evaporation occurs, (2) at which evaporation is occurring ;

(*b*) Prevention of corrosion on surfaces (1) and (2) of (*a*) ;

(*c*) Selection of chemical treatment on the basis of non-condensable gases that are permissible in the steam ;

(*d*) The control of sludges and soluble salts in the boiler water ;

(*e*) The removal of entrained moisture from the steam.

Prevention of Scale Formation on Evaporating Surfaces.

The following expression serves as a general criterion for the elimination of scale formation on the evaporating surfaces :—

Concentration in the boiler water of chemical used in treatment = Function of (*a*) the operating pressure, (*b*) concentration of sulphate (SO_4) in the boiler water.

This expression makes no limitations regarding the type of feed water to be used or as to the methods of conditioning which will be employed. It makes no specifications whatever regarding the methods which will be used for removing any sludges produced. It is a generalised statement of the fact that the two major factors to be considered in prevention of scale formation on the evaporating surfaces are operating pressure and the sulphate concentration in the boiler water. Two principles governing adherent scale formation on the evaporating surfaces must be recognised in order to define the term, chemical used in treatment.

(1) The adherent scales which grow in thickness are formed by deposition from the boiler water directly on the surfaces where found when the boiler is opened. This may be called deposition *in situ*. There are three substances which deposit from the boiler water in this manner, namely, calcium sulphate, calcium and magnesium silicate.

(2) The solubility of substances which form adherent scales decrease with temperature increase ; *vice versâ*, those substances which separate from the boiler water as sludge increase in solubility with temperature increase.

Therefore the chemical used in the final conditioning of the boiler water must be one that if maintained at the concentration defined by the operating pressure and the amount of sulphate present in the boiler water, prevents the formation of any calcium sulphate or calcium and magnesium silicate at the evaporating surfaces, and ensures the separation of sludge forming substances only.

This discussion has to do only with the final conditioning of the boiler water, and consideration will be given to but two substances which meet the requirements noted above, namely, sodium carbonate (Na_2CO_3, soda ash) and sodium phosphate (Na_3PO_4). Sodium carbonate and phosphate have been specified because they can be purchased in the market more cheaply than other carbonates or phosphates. It must be recognised, however, that they are used because of their available carbonate (CO_3) and phosphate (PO_4) content, and that other than their sodium compounds, as, for example, their potassium compounds, might be used if they were cheaper or if a special reason existed for their use, as, for instance, in the use of barium carbonate ($BaCO_3$).

Regardless of any pre-treatment which may have been given to the feed water, the essential relation to maintain in the boiler water is expressed thus, when soda ash is used for the purpose—

$$CO_3 = K_1 \text{ (at operating pressure } p) \times SO_4.$$

If sodium phosphate is used, then the expression becomes

$$PO_4 = K_2 \text{ (at operating pressure } p) \times SO_4^{\frac{2}{3}} \times D^{\frac{1}{3}}(SO_4).$$

In these expressions, CO_3, PO_4 and SO_4 are preferably measured in parts per million, though grains per gallon may be used as well. K_1 and K_2 are specific for CO_4 and PO_4 respectively, and are constants for a definite operating pressure p, but vary with variations of the operating pressure. D refers to the relation of ionic to total SO_4 in the boiler water and is a function of the operating pressure and of concentration of SO_4. As an example of the application of these criteria at the operating pressure of 150 lb. gauge—

$$K_1 = 8{\cdot}83 \times 10^{-2}.$$

Thus, if the sulphate concentration in the boiler water is 1000 p.p.m., the concentration of CO_3 therein must be slightly more than 88 p.p.m., &c.

For the use of phosphate at this operating pressure—

$$K_2 = 1{\cdot}64 \times 10^{-4},$$

when concentrations are expressed as parts per million.

For a concentration of 1000 p.p.m. of SO_4, D = 0·65 ; for 2000 p.p.m. of SO_4, D = 0·59. Substituting these values in the general equation for the use of phosphate, we find that for a concentration of 1000 p.p.m. of SO_4 in the boiler water, the essential concentration of PO_4 necessary to prevent adherent scale formation is slightly more than 4 p.p.m. and for 2000 p.p.m. of SO_4 slightly more than 11 p.p.m. Simple types of apparatus are described for the determination of SO_4, PO_4 and CO_3 in the boiler-room.

The Relation Between Chemical Used in Treatment and Operating Pressure.

It is evident from the expression—

$$CO_3 = K_1 \text{ (at operating pressure } p) \times SO_4,$$

that the maintenance of scale free conditions depends upon keeping a definite supply of CO_3 in the boiler water. At boiler temperatures, however, soda ash decomposes according to the reaction—

$$Na_2CO_3 + H_2O = 2\,NaOH + CO_2,$$

and the rate of its decomposition is a function of the operating pressure, and the rating at which the boiler is operated. These two therefore in conjunction with the concentration of SO_4 in the raw make-up water and blow-down practice are the elements which control the feasibility or infeasibility of maintaining the necessary CO_3 concentration. Thus higher operating pressures are characterised by more rapid decomposition of CO_3 ; and at the same time by the necessity for maintaining higher CO_3 concentration, since the value of K_1 is greater at higher than at lower operating pressures. In a boiler operating at low rating, it may be possible to maintain the necessary amount of CO_3 in the boiler water, while in the same boiler at high rating the more rapid decomposition of CO_3 may render such maintenance impractical unless blow-down of uneconomical proportions is resorted to. The basic cause for these troublesome limitations in the use of soda ash lies wholly in its decomposition into caustic soda and carbon dioxide. Also, apart from the uncertainty of maintaining satisfactory CO_3 concentrations, the high caustic alkalinity developed in this decomposition makes it impossible at higher operating pressures to keep within the alkalinity-sulphate ratio recommended in the proposed boiler code as insurance against embrittlement. The remedy lies in the substitution for CO_3 of a substance satisfactory from the standpoint of scale prevention and entirely stable at the operating pressures. It has been one of the most pleasing developments of this investigation to establish the proof that PO_4 gives beautiful results on the side of scale prevention, and that the total alkalinity necessary in the boiler water can easily be kept well within the limits recommended from the standpoint of caustic embrittlement.

A satisfactory and economical answer to the complete conditioning of water for high pressure operation may be given as follows :—

If the make up water is evaporated and the only impure water entering the boiler consists of the condenser leakage, then the conditioning of the boiler water with phosphate is the only chemical control necessary. If the make-up water is not evaporated and is of some magnitude, then economy demands the pre-treatment—with lime and soda ash for any water or by a base exchange process if the water is not high in temporary hardness—followed by the final conditioning of the boiler water with phosphate. In the pre-treatment, however, any addition whatever of excess chemical must be avoided else detrimental concentrations of caustic alkalinity will develop in the boiler water. If it is deemed desirable to limit the amount of soluble solids in the boiler water and the feed water is one that contains sulphate, a variation in pre-treatment may be made by using barium carbonate in place of sodium carbonate, thus removing much of the sulphate as well as

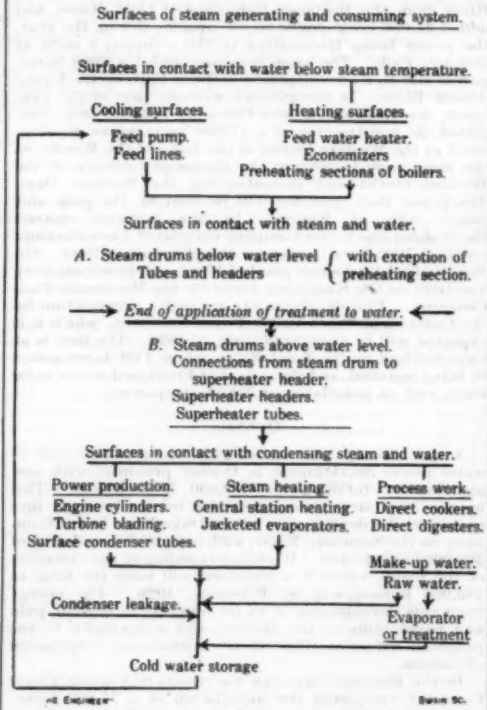


DIAGRAM SHOWING CONDITIONING OF BOILER WATER

the calcium. In any event, however, the final control of the boiler water must be based on the use of a suitable substance, such as phosphate.

Prevention of Scale Formation on Feed-water Lines and Pre-heating Sections.

The problem of scale prevention is much simpler on these surfaces than on the evaporating surfaces, since (1) there is only one main constituent in these scales, namely, calcium carbonate ($CaCO_3$) ; (2) deposition of insoluble solid material occurs by reason of supersaturation throughout the body of the water and not at the surfaces alone, as in the case where evaporation is occurring ; and (3) no decomposition of the chemical used in treatment occurs.

In order to prevent scale formation on these surfaces, it is necessary that no bicarbonate (HCO_3) remains in the water, and it is advisable that a small concentration of caustic soda (NaOH) and loose crystals of suspended calcium carbonate be present. This condition may be maintained in a water which has been correctly treated externally or by using the excess caustic alkalinity in the boiler water itself. The latter control involves re-circulating water from the boiler through the feed lines or the pre-heating sections.

The Prevention of Corrosion on the Surfaces in Contact with the Feed of Boiler Water.

On the basis of experiments which are described under this heading, it is concluded that in general any corrosion of the boiler system surfaces in contact with water is electro-chemical in character. Anodic conditions in the metal develop from differential oxygen concentration, especially in feed lines and economiser tubes, from impurities in contact with the metal—as mill scale—or from a state of strain or local differences of temperature. The control of corrosion therefore signifies so conditioning the water that at any anodes which may develop, passage of current generated results not in the dissolution of the boiler metal, but in the discharge at the anode of some component in the boiler water. It is our belief based on experimental work and operating control now in progress (1) that hydroxide (OH) is specific in this respect as regards sulphate waters, and satisfactorily inhibitive for practical purposes as regards chloride ; (2) that the control for inhibition of corrosion is as exact as that given for elimination of scale formation ; and (3) that even in the extreme case of a raw water saturated with air, feed line or economiser corrosion can be reduced to negligible proportions.

Control of Non-condensable Gases in the Steam by Conditioning of the Boiler Water.

In general, the necessity for controlling the concentration of carbon dioxide in the steam arises most frequently. For such control the obvious thing to do is to keep all carbonates so far as possible from the boiler water. If the make up water is evaporated directly, control of the boiler water with PO_4 limits the quantity of carbon dioxide to the amount derived from condenser leakage. If the feed water is given primary treatment with lime and soda ash, it is necessary to avoid excess of treatment and to use a secondary control with PO_4 on the boiler water. If the feed water contains temporary hardness, and is treated by a base exchange process, it may be necessary to remove the excess sodium bicarbonate in the water after treatment by the use of acids or other means, and the final control must be established on the boiler water with a chemical which does not decompose at the operating pressures in question.

Other Factors in Boiler Water Conditioning.

The control of sludges and soluble salts in the boiler water, their relation to wet steam and the removal of any boiler water and its suspended insoluble material from the steam before it leaves the boiler nozzle, are as integral parts of any complete system of boiler water conditioning as the factors which have been considered already. It was the purpose of this paper, however, to present those features of such a system in which the Bureau of Mines is actively co-operating. This has been done, and I must therefore extend this discussion no further.

JUNIOR INSTITUTION OF ENGINEERS.

Mr. W. H. Patchell, M. Inst. C.E., took as the subject of the Honorary Member's Lecture, which he delivered to the Junior Institution of Engineers on February 12th, his visit to some of the power stations in the United States of America in 1925. Prefacing his remarks with a reference first to the map of North America, and then to diagrams showing the development of communications and power services, Mr. Patchell described with the aid of lantern slides the stations at Trenton Channel, Philo, Lake Shore, Crawford-avenue, Boston, Hudson-avenue and Muscle Shoals. All, he explained, were steam turbine stations, except the last named, which used water power from the Tennessee River. The lecturer's descriptions and comments had, of course, for the most part direct reference to the illustrations on the screen, and therefore cannot easily be recorded alone. One or two things which he said, however, may be mentioned. The first was that large power stations existed in the United States, because conditions of supply were such that it paid all commercial firms and domestic households to use electricity. The demand was met because large plants were put down in the first place to save labour costs, and ever since that time the engineers had realised that in electricity they had something to sell. Machines of 50,000-kilowatt capacity were none too big when the load on one system varied by 60,000 kilowatts between a dark day and a light day. It was remarkable that in Great Britain everybody waited for the Government to decide upon a standard frequency. Was not uniform periodicity a commercial problem ? What they did in America was to put in frequency changers such as the 35,000-kilovolt-ampère machine at Brooklyn, and it paid to do so. A comparison between British and American electricity prices was very hard to make, for the same reason that it was difficult to compare the prices of every-day food. American charges might seem greatly different in different towns, but that was because the unit charges were based on a standard rate which might be proportionate in one municipality—for example, to house frontage.

Royal Institution.—On Saturday, March 6th, Sir Ernest Rutherford commences the first of four lectures on "The Rare Gases of the Atmosphere," at 3 p.m. The Friday evening discourse on March 5th will be delivered by Sir Henry Maybury, on "London Traffic," and on March 12th by Sir J. J. Thomson, on "Radiation from Electric Discharges."

American Honour for an English Writer.—We learn with much pleasure that the United States Naval Institute has awarded a gold medal for a prize essay to Mr. Hector C. Bywater, a well-known writer on naval matters. We believe that this is the first time for twenty-five years or more that the prize has fallen to an Englishman, the last English recipient being the late Mr. W. Laird Clowes. The anonymity of the authors is very strictly preserved from the judges.

Co-partnership and Co-operation.—Four years ago Mr. Littlejohn Philip decided to retire from the firm of Spencer (Melksham), Ltd., after a connection with it of forty years, since, in fact, he had founded the business. Circumstances having rendered his return desirable, he was recently approached with a request again to take an active part in the management. When he retired in 1922 Mr. Philip distributed to every employee £1 for every year's service with the company. At an entertainment which was given on the 6th inst. to celebrate his return, he announced that he had purchased shares, giving a voting power of approximately 100,000 votes, which he proposed to distribute among the staff and employees of the company. He furthermore promised that, seeing that the workpeople had agreed unanimously to co-operate with him in carrying on the business, he had decided that, when a dividend was paid on the preferred shares of the company, he would divide all he personally received from salary and bonus on profit, less Imperial taxation, equally with the men. The secretary of the company was, he added, to be accepted by both sides as the sole judge of the amount to be distributed.

Cutting Temperatures.

A MEETING of the North-Western Branch of the Institution of Mechanical Engineers was held at the Engineers' Club, Manchester, on Thursday, February 4th, Mr. Cecil Bentham in the chair, when Mr. E. G. Herbert presented a paper on "The Measurement of Cutting Temperatures," an abstract of which was published in THE ENGINEER for January 1st, 1926.

Opening the discussion, Professor G. G. Stoney said that it was one of the most important papers that they had had before the branch. The minimum work hardening temperature of about 150 deg. Cent. was about the same as they had found for the minimum elongation of mild steel in a testing machine. There was probably something taking place in steel at about 150 deg. Cent. about which they really knew very little at present. Mr. Dempster Smith's work and Mr. Herbert's work both confirmed that there was some change in the molecular structure of steel at that point. He did not think anything could be seen under the microscope. Tempering took time. In his experience springs lost their elasticity at very much lower temperature if they were subject to heat for a long time. He thought it was quite possible that the chips might get hotter after they were actually off, because there would be undoubtedly in the strained material a very vigorous re-arrangement until it got to a permanent state. Professor Stoney thought Mr. Herbert's method of a string galvanometer and the thermo-couple consisting of the tool and the work was a most ingenious combination, for which a great many developments were possible. What was the temperature of a rail when the locomotive passed over it? What was the temperature of gear teeth, especially when they chattered? Such things undoubtedly lent themselves to be investigated by Mr. Herbert's method.

Mr. Dempster Smith said, with regard to the variation in the force with speed which he had found, and to which Mr. Herbert had drawn attention and had attributed to a variation in the temperature of the chip, that while he recognised that temperature did play a part he was not prepared to associate the diminutions in the force with the temperatures given. Whilst he was able to reconcile three series of experiments with the variation in the physical properties corresponding to the temperature changes, he had not been able to do it with a fourth series of trials, and withheld his conclusions until further evidence was forthcoming. It still remained to reconcile the change in the steel at those different temperatures with the change in the durability of the tool. In conjunction with one of his colleagues, Mr. Andersen, he was continuing the investigation on the increase in temperature due to cutting when operating on bronze. He found that the temperature increased with, but not quite so rapidly as, the speed. Time or duration of treatment was a factor affecting the change. A question arose in his mind as to how many blows they could make with a chisel without raising its temperature, and so causing it to become soft. Mr. Herbert had mentioned that the temperature rose so rapidly that the hardness was not affected, but it seemed that the cumulative effect of frequently raising the temperature was bound to make itself felt in the destruction of the hardness of the steel.

Mr. Herbert, in reply, said that Professor Stoney's remark that the minimum elongation in steel was found at 150 deg. was particularly interesting, because he (Mr. Herbert) had been on the look-out for something that he could identify with those various points. The nearest he had been able to find had been in certain German results, and in the results of Dr. Lea, of Sheffield, reaching from a very low minimum reduction area at about 300 deg. Dr. Lea had made his tests at intervals of 50 deg., so it might have been 250 deg. or it might have been 300 deg. He (Mr. Herbert) wondered whether that very low minimum of reduction of area was connected with one of his peaks—the one which he called the P_3 peak, which came somewhere in that neighbourhood. He was very much obliged to Professor Stoney for not "sitting on" him for suggesting that chips could get hotter after they came off. That anyone with his (Professor Stoney's) authority should not have considered that suggestion an absurdity gave him very great encouragement, and he hoped eventually to go a little further into that by making records of the temperature rise and the contact between the striking and the struck body, to see whether they did synchronise or whether the temperature rises occurred after the blow. Mr. Dempster Smith doubted if the temperature of 120 deg. was the temperature of the chip; he thought it was much higher. Mr. Herbert quite agreed. He had had a great deal of evidence that the temperature that he had measured with the thermo-couple was not the significant temperature in relation to the machinability of the metal. With regard to the shaping curves, he had obtained clear evidence that the temperature, when he had been running at a higher speed, had been at least 700 deg. He thought it was not difficult, if one tried to analyse what happened when a tool was cutting steel, to see that the temperature that he was measuring was really a maximum temperature, and was considerably higher than the temperature of the steel when it was still a part of the bar, which was really the significant temperature in relation to the work-hardening properties of the steel. The steel was first crushed and its temperature was raised by inter-molecular friction to some extent. Then it was crushed and work-hardened; then separated. Then the work-hardened chip came down on the tool with enormous pressure, and created an ultimate temperature by friction. That was the temperature they had measured and that was the temperature that the tool had to stand without becoming soft.

ON January 8th, the German Railways introduced train telephones into regular service on the Berlin–Hamburg section. A carrier wave system is employed, use being made of an aerial attached to the roof of the coaches. Wireless communication is established between the train aerial and the telephone wires which run parallel with the track. By this means passengers travelling on the train can communicate through a special railway exchange with the ordinary trunk exchanges.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Conditions.

THERE has been but little new movement in the Midland iron and steel trades during the past week, and the situation remains much as it was. Consumptive demand shows no expansion, and the policy generally adopted is to draw upon raw material already bought, and wait for events to develop regarding the coal *impasse*. The first quarter of the year is often a moderate one, and this year business did not begin to come in as early as usual. Industrialists, on the whole, incline to the opinion that the outlook is brighter. Certain sections of the iron and steel industries have experienced a modified improvement on the last quarter of 1925, but actual movements are themselves slight. The general market tone is steady.

The Steel Trade.

The steel trade is gradually improving as far as demand is concerned. Midland constructional engineers now find a steady flow of inquiries, and are busier than for many months in tendering for building enterprises of various kinds. The railways are regular customers and are issuing new schemes for bridge and station reconstruction, representing in the aggregate fair tonnages. Unfortunately for steel masters, price improvement has been found practically impossible in the finished department. The only line in which this has been seriously attempted is that devoted to joist and sections, for which £7 5s. is quoted. It is, however, still possible to buy at £7 2s. 6d., and for a good line £7 would not be refused. The failure of the market to gain strength causes uneasiness, lest it should end in a reversal of the hoped-for tendency. Small bars can be bought at £7 17s. 6d. Continental bars are offered at about £6 11s. 6d., delivered here. Ship, bridge and tank plates range from £7 15s. to £8, and boiler plates from £11 to £11 10s. Staffordshire hoops command £10 10s. at works. Continental offerings of soft billets are small, and the price tendency is towards firmness. Belgian material can be bought at £5 11s. to £5 12s. delivered, while most of the British makers require about £6 5s. Steel strip sells at £7 15s. for thick and wide sizes. It is commented upon that production of steel ingots and castings is improving, last month's figures amounting to 635,700 tons, compared with 606,800 tons in December—when production was affected by the Christmas holidays—and 605,100 tons in January, 1925.

Raw Iron.

The Midland makers of pig iron can sell all they are disposed to contract for, but there is still the uncertain coal position which prevents any forward contracting beyond the subsidy period. The northern trade is being assisted a little by slight easing of coke, though this fuel in the Midlands is inclined to be dearer, and undoubtedly assists in maintaining the firmness of prices. Steps have not been taken, so far as can be gathered, to bring smelters and ovenmen together again in the interests of a stabilisation of coke prices. Demand is steadily maintained, but there is no trade development to call additional blast-furnaces into activity in the Midlands. Pig iron consumers claim to be able to buy some grades at rather less than the rates quoted. At the other end of the scale prices are named which merely signify that the producer has sold as much as he cares to sell. A quotation of £3 10s. at furnaces for Derbyshire No. 3 foundry is a case in point. Sellers of East Coast hematite want £3 14s. for mixed numbers. It is satisfactory to note that there were 144 furnaces in blast throughout the kingdom at the end of last month, a net increase of three since the beginning of the month, seven furnaces having been put into blast during the month and four either damped down or blown out. The record of production during the month is not so gratifying. It amounted to 533,500 tons, compared with 503,400 tons in December and 574,500 tons in January, 1925. The output included 178,100 tons of hematite, 183,200 tons of basic, 121,700 tons of foundry, and 21,800 tons of forge pig iron.

Staffordshire Bar Iron.

The demand for finished iron is not great, though perhaps it is a trifle better than it recently was. More material is going into the Birmingham and Midland rolling stock works, which are better occupied than recently. The orders given out are not for large tonnages, but by many Staffordshire works contracts are placed with more regularity. No difficulty is experienced in obtaining £14, the basis rate, for marked bars. Crown bars are generally on the same basis as Lancashire now, £11 10s., but there is less disposition to sell at this figure. Continental prices do not improve, despite frequent assurances from foreign exporters to that effect. But it is understood the works are booked till May, and slow deliveries are therefore a factor to be reckoned with. Belgian common finished iron, such as is used in the nut and bolt and fencing trades, is, however, now being received in heavier consignments. For Belgian No. 3 bars Antwerp shippers quote the equivalent of £6 15s. delivered here. Big buyers will not pay £3 15s. more for bars rolled in Staffordshire mills, except under very special circumstances. The Staffordshire tube makers are busier, and although a large proportion of the material used is steel strip, because it is cheaper, iron strip is receiving more attention. The quotation is about £12 10s.

Galvanised Sheet Values.

Galvanised sheets are inquired for on a rather more promising scale for the home market. Actual business done has not been sufficient to arrest the downward trend of prices, however, buyers being unwilling to concede much more than £16 for corrugated sheets of 24 gauge where they have orders of any size to place. A few makers are asking £16 2s. 6d. and £16 5s. for small tonnages, but consumers do not appear to be prepared to pay the latter figure.

Scrap.

Steel scrap is rather firmer on the basis of £3 10s. delivered South Wales, although no great amount of business is passing. Wrought iron filling scrap is quoted £3 17s. 6d. to £4; ordinary bundling scrap 5s. less.

Foreign Competition in the Engineering Trades.

In my letter of January 29th I gave prominence to the expressed belief of a director of a prominent Midland engineering firm in the prestige of British products and the ability of Great Britain to hold its own in the markets of the world. A Buenos Aires correspondent writing recently to a Birmingham firm of importers complains of the quality of British exports to that market, and states that some manufacturers are getting a bad name as a result. He refers also to the quality of American and German imports. The following extract from his letter does not make pleasant reading, and it behoves Midland exporting engineers, in common with those in other parts of the country, to pay attention to the all-important question of quality. "British goods," says the writer, "have always stood here as of good quality, and up to standard or sample, and as the prices are generally higher than others, buyers expect better-class goods than from other countries. German goods are considered inferior in quality, but as their prices are lower, buyers do not expect so much from them, and we must say that in this market at least we seldom hear of complaints that the goods received are not what have been ordered. The United States, on the contrary, have a very bad name here, which they mostly established during the war, when they took orders on samples, insisted on payment in advance, and shipped anything. It would appear that British manufacturers are on the highway to get the same bad name, as evidently they are thinking anything will do for export now. The writer was talking only a few days ago to a responsible employee of one of the British railways here, who said that the railway was buying any quantity of German goods against sample, as they got better quality than the stuff which was sent out from England."

Further Railway Contracts.

Two further railway contracts are to be executed in the Birmingham rolling stock works. The Buenos Aires Western Railway has awarded a contract for 100 cattle wagons to the Birmingham Railway Carriage and Wagon Company, Ltd., Smethwick, and an order for fifty fish vans for use on passenger services of the Great Western Railway has recently been placed with the Metropolitan Carriage Wagon and Finance Company, Ltd., Saltley.

Unemployment.

A further decrease in the number of unemployed in the Midlands is recorded for the week ended February 8th. The total of wholly unemployed is 126,516, as compared with 129,754 in the previous week and 134,448 a fortnight ago. The number on short time or temporarily unemployed also shows a further improvement, the figure being 39,798, whereas it was 44,577 a fortnight ago. The total of wholly unemployed in the Birmingham area now stands at 23,870 and temporarily unemployed 2642; while in Coventry the totals are respectively 1508 and 329. While in Birmingham these figures are an improvement on the previous week, at Coventry they are slightly higher.

Colliery Company's Co-partnership Scheme.

The principle of co-partnership in the mining industry is to be introduced into the Staffordshire coalfield for the first time by the Cannock Chase Colliery Company, Ltd., the senior concern of its kind on the Cannock Chase. Only one other firm of coalowners in the kingdom, the Staveley Coal and Iron Company, Ltd., Derbyshire, it is understood here, have such a scheme in operation. The Cannock Chase Company has this week decided to offer to the men 1000 £10 ordinary shares fully paid to any men who have been in the employ of the company for five years. Applications have to be accompanied by payment in full of the stock applied for. The company employs 2500 men, and I hear that there is every prospect of a considerable number availing themselves of the opportunity to become shareholders. The firm believes that along these lines is the best solution of many of the problems with which the coal industry is now faced.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The General Outlook.

THERE was a fair, though not large, attendance on the Iron Exchange, but the feeling of optimism reported in other centres is not very noticeable here. The depressed and uncertain state of the cotton trade is undoubtedly affecting the position, and until a marked and regular improvement is apparent in Lancashire's staple industry, the present apathetic attitude is likely to prevail in a greater or lesser degree. A substantial proportion of the spindles and looms is lying idle, owing either to lack of material or to shortage of labour, and under present financial conditions millowners show no disposition to replace machinery, except where absolutely necessary. From the foregoing, however, it must not be assumed that the iron and steel trades in Lancashire are dependent on the cotton trade as an outlet for their products, as a fair amount of general constructional engineering is in progress in the city, and in that direction a satisfactory amount of material must be going into consumption. Reports with regard to the shipbuilding industry are much brighter, and with more activity reported from the East Coast, that is bound to be reflected here; but, though at present the market for semi-steel is rather better, the demand for

steel angles and plates is by no means brisk. Reports as to foreign competition are more cheering. Owing to higher cost of production and kindred financial considerations on the Continent, prices of foreign material are approximating more to that of our own manufacturers, which fact has resulted in some orders being placed with British producers, which would otherwise have gone abroad. This is a step in the right direction, and it is significant that many firms which have hitherto been using Belgian material, have turned their attention to English steel. Advices received here from the North-East Coast point to a much better feeling with regard to the fuel question, and good foundry coke is, it is said, being offered at reasonable prices, and whilst there is some hesitation on the part of ironmasters, a few more blast-furnaces are being put into commission in Cleveland and also in Scotland. In all departments buyers and sellers act cautiously, and though fears are expressed as to the future should coalowners and miners fail to come to a mutual agreement, on the other hand, large orders are pending if only a peaceful solution is arrived at.

Pig Iron.

There was a steady feeling in all descriptions of pig iron, and with buyers showing little inclination to operate far forward, business can by no means be described as brisk. For some brands it was stated that something under list prices had been accepted, but, on the other hand, it could not be said that sellers showed any disposition to press for business. Consumers appear to be fairly well covered for immediate wants, and are apparently adopting a policy of drawing on material already in stock. Quotations to a certain extent must be regarded as nominal, Staffordshire and Lincolnshire No. 3 foundry being on a parity at around 76s., with Derbyshire obtainable at 75s. to 76s. per ton. Hematite is reported to be in demand, notwithstanding the upward trend in prices, and makers are reported to be well booked for some time ahead. West Coast hematite ranges from 90s. to 97s. 6d. per ton, according to point of delivery.

Finished Material.

A fair, though not large, amount of business is coming forward, but there seems to be some cessation of the undercutting noted last month. There are reports of good railway and engineering developments in the near future, and this, in conjunction with more activity in the wagon-building works, should give increased confidence to the trade. While steel makers are by no means working to the limit of their capacity, it is significant that many firms which have hitherto used Belgian sheet bars, blooms and billets are now using English steel.

Scrap.

As in other departments, both buyers and sellers of scrap metal appear to be "marking time," and while dealers at present have not been able to enforce higher prices, the stronger feeling in forge pig and foundry iron is bound to affect the position in the long run. The market, however, is following very slowly the favourable influences in other branches of the industry. There is an absence of speculative buying, though some small parcels have changed hands at easier figures. For steel melting scrap prices on spot are around 55s., with heavy steel melting scrap about 57s. 6d., though this must be of very good quality to command this figure. Cast scrap iron is variable at anything from 70s., with textile scrap up to 77s. 6d. Heavy wrought scrap ranges from 65s. to 70s. per ton. All foregoing quotations f.o.t. Manchester.

Metals.

With one or two exceptions, demand for non-ferrous metals rule quiet. Copper has appreciated, but buyers show little inclination to operate, except for immediate wants. Stocks are reported to show a considerable decline as compared with last year, but this is regarded as of a temporary character only, as with new plant coming into operation this deficiency will soon be made good. Lead is firm, though consumers are stated to be buying sparingly. There is little new to record in tin, though the high prices ruling check demand to a certain extent. Spelter remains fairly steady, galvanisers reporting new business which will keep them employed for the next month or two.

Fuel.

There was a fair average attendance on the Manchester Coal Exchange. There was little change in the general position, best grades of house coal clearing readily, but medium and lower qualities are somewhat difficult to move and show signs of accumulating. Slack and industrial fuel also rule quiet, and while prices of screened gas coal are steady, demand for foundry coke on spot is rather on the slow side.

Manchester Association of Engineers.

THERE was a very good muster of members and friends at the annual dinner of the Manchester Association of Engineers, which was held at the Midland Hotel on Friday, the 12th inst. Mr. R. Onions, M.I. Mech. E., the President, was in the chair, and speaking in reply to the toast of "The Association," proposed by Sir Thomas Robinson, said that the society had always been prosperous. At the present time it had between 800 and 900 members, and it might be said to be the clearing house for information for manufacturing engineers. Referring to a remark made by the proposer of the toast respecting Manchester's position in the industrial world, Mr. Onions said this city had been the centre of civilisation as far as engineering was concerned, having produced such men as Dalton, Joule, Nasmyth, Whitworth and Fairbairn. Mr. Onions attributed to Nasmyth the saying that free trade in ability was even more important than free trade in commodities—a remark which he considered as true to-day as ever. The toast "The Port and Trade of Manchester" was submitted by Mr. Daniel Adamson, M.I. Mech. E., who said that engineering was the poorest but the most efficient of all trades. It had one redeeming feature, namely, that as soon as the commercial atmosphere improved, people began to spend money, some of which found its way into the pockets of the engineers. In reply to this toast Captain W. C. Bacon, the Chairman of the Ship Canal Company, gave some interesting figures on the progress made by that waterway. He said that last year was a peak year for both tonnage and receipts. Ships up to 16,000 tons deadweight could now make use of the Canal. The toast "Municipal Institutions" was proposed by Mr. Alfred Saxon, M.I. Mech. E., and the reply to it was made by the Lord Mayor of Manchester and the Mayor of Salford. "Our Guests" was proposed by Alderman Fred J. West, M. Inst. C.E., and was acknowledged by Colonel J. S. Ruston. Colonel Ruston spoke regretfully of the changed conditions between employers and men, and expressed a strong desire for a better understanding between them.

Wigan Coal.

Although the Wigan Coal and Iron Company has paid a dividend every year since its formation in 1865, last year's working resulted in a loss of £157,000, in spite of the coal subsidy. In their annual report the directors state that the developments at the Parsonage Colliery at Westleigh are now completed, and the output is increasing satisfactorily. Two coke-oven batteries were put out of commisison during the last quarter of the year, but they are now at work again. The new by-product plant is in full work, and is giving satisfactory results. Two blast-furnaces were in operation during the first nine months of the year, and the slight improvement in the iron trade enabled the company to put these furnaces back into blast at the beginning of January. The steel works worked intermittently throughout the year.

A Diesel Engine Order.

An order has recently been received by Mirrlees, Bickerton and Day, Ltd., for three 750 brake horse-power Diesel engines of six cylinders each, from the La Guaira and Caracas Railway Company. These engines are to drive dynamos for the electrification of the line in Venezuela, and will form an additional source of power to the hydro-electric system which is already in use.

BARROW-IN-FURNESS.

Hematite.

If anything, there is an easing off in the hematite pig iron trade. This tendency may be attributed to two causes. First, there is an inclination to revert back to the hand-to-mouth method of buying, and, secondly, there is the fear of an unsettled state of industry arising from the coal trade problem. It is stated by some that the competition from the East Coast is taking away some of the orders, but this assertion is questionable. As a matter of fact, trade when it improved was inclined to take up too big an impetus, and it is now coming down to the level compatible with present conditions. At some of the works stocks are beginning to accumulate, but some of the stocks are awaiting customers' orders. The Midlands continue to be the best customers. The amount of business with the Continent is limited, and there are also contracts with America for a certain amount of tonnage. Both as regards the Continent and America, the iron is above ordinary qualities.

Iron Ore.

There is nothing fresh to report as regards the iron ore trade, which continues to be moderate. Until there are more furnaces put in blast there will be no improvement, for the outside demand is small. Foreign ore from Spain and Norway is being brought in in limited quantities, just sufficient to meet present requirements.

Steel.

The steel trade is about the same, and there is nothing fresh to report as regards further orders. This district will get its share of the contracts which are being given out. Workington is not fully employed, and there are periods of idleness at the rail mills. At Barrow the rail mills are employed, as also are the hoop and small section departments.

Hydro-electric Scheme for Barrow.

There is a considerable difference of opinion in Barrow-in-Furness concerning the Town Council's decision to proceed with the Backbarrow scheme for tapping the river Leven near the foot of Windermere Lake. The Ratepayers' Defence Association is strongly opposed to the carrying out of the scheme and is asking for permission to interview the Electricity Commissioners on the subject.

SHEFFIELD.

(From our own Correspondent.)

Iron and Steel Trade Returns.

IRON and steel and their manufactures that were exported last month totalled 336,644 tons, which was 10,000 tons more than the figure for January last year, but was 4000 tons less than the December figure. Making a comparison from the point of view of values, last month's returns were far from satisfactory, and with these figures in mind one can readily appreciate the difficulties which to-day face iron and steel makers. In the Sheffield, Parkgate, Templeborough and Stocksbridge steel-producing areas, the open-hearth furnaces in commission have been slightly increased, and to a certain degree this is a satisfactory feature. On the whole, however, steel sales have not materially moved up, and in the absence of forward business the position from week to week does not show much confidence. There is very little of a cheerful nature to be derived from a survey of the price list. The advance which was made recently in pig iron barely balanced the extra price that makers were having to pay for fuel and other raw materials, and yet the pig iron market is so lacking in strength that this late figure is only being maintained with difficulty. The scrap market tends to move in favour of the merchants, and they are asking 65s. per ton delivered works for heavy basic steel scrap for melting. This is half-a-crown more than consumers' terms, but the majority of the comparatively few transactions are taking place at the higher figure. It is stated, however, that a good many outside buyers are operating in the local market.

Stainless Steel Development.

I have made several references to the wider application of stainless steel, and the latest development is attracting considerable attention. Sheffield has decided to give a trial to stainless steel fittings for its tramcars. Experiments towards this end have been proceeding for several years, and it is now claimed that an article has been produced which will justify its substitution for brass, the metal now in use. Steel is the more expensive article, but to set against the extra initial outlay will be the saving in the cost of cleaning, and this is a big item in car maintenance. More than thirty metal fittings and more than a hundred articles on each car will be affected by the change in Sheffield. A few days after the announcement of the Sheffield decision, Leeds decided to follow suit, and the manager has arranged for a full set of these fittings to be put on one of the cars being erected at the Corporation's depôt. Two hundred cars are now on order for Leeds, of which 150 are being built by contractors, and it will probably be too late to make any alteration to these. The remaining fifty cars, however, are being built by the Corporation, and in this case it is not too late to make a change. It is on one of these cars that the trial will be made. Tramway engineers throughout the country will await the reports from Sheffield and Leeds with interest, and should the trials prove satisfactory, there is no doubt that stainless steel fittings will be generally adopted. If so, local trade will receive a substantial stimulus. The metal that has been approved by both cities has been prepared by Mr. W. R. Hardy, in co-operation with the firms of John Holding and Bartholomew, of Sheffield.

Engineering Departments.

The railway plants are fairly actively employed, though there are still many shops standing idle, largely for want of foreign business. Overseas orders are going to continental firms in large proportion, some valuable Indian business being the latest to be placed there. The competition, owing to the big price advantage, is too serious to be easily overcome. The home railways have a good deal of work on order. One of the latest contracts to be placed in which Sheffield has an interest is for fifty fish vans for use on passenger services on the Great Western Railway. The work goes to the Metropolitan Carriage, Wagon and Finance Company, which is a subsidiary company of Vickers Ltd., of Sheffield. Some controversy has arisen over the question of Sheffield's ability to produce plates for cast iron houses. An authority on housing in the city asserted that there was not the plant to turn out the plates quickly enough, and to this a prominent member of the Sheffield branch of the Institute of British Foundrymen replies that in the Sheffield area alone there is sufficient foundry capacity to turn out plates for cast iron houses for all the houses needed by the nation. "It is only a matter of conversion," he says, "and that could be done in very quick time were the foundries satisfied that there was a demand for this class of house. A few moulding machines on repetition work of the kind necessary can turn out an amazing number of plates in a short time. Existing foundries which work at present in cast iron, as apart from the steel foundries, could supply all Sheffield's needs in quick time."

Tools, Plate and Cutlery.

A distinctly cheerful tone is noticeable in the lighter steel trades of Sheffield. Good orders are to hand for nearly all classes of tools and the volume of inquiries indicates that the forward movement will be maintained. The export position is undoubtedly improving, and a satisfactory feature about the increased home trade is that it can only mean a return of better trade to tool-using industries. Spades, shovels and farm implements are selling very well, and larger quantities than for some time past are going abroad. The plate and cutlery trades have not yet got into their swing again. Little business is passing through the ordinary retail channels, and most of the work on hand is for catering companies. In view of the tremendous inrush of foreign cutlery at the end of the year to evade the new duty, the import figures for January are interesting and rather surprising. January's imports of cutlery were of the value of £26,287, which is almost the same as in January, 1924, though it is £13,000 less than in January, 1925. Cutlery exports from this country were down in comparison with the corresponding period in the two previous years, and there were marked drops in the shipments to Australia and New Zealand.

Rich Coal Seam Proved.

The analysis of the coal struck in the new shaft at Markham No. 1 Colliery, owned by the Staveley Coal and Iron Company—a development to which I referred last week—has given very satisfactory results. The coal is what is known as "brights" and is particularly suitable for domestic purposes and gas manufacture. The seam is 4ft. 6½in. thick, and the work of equipping the shaft and getting the pit bottom ready, providing ropes, cages, guides, &c., will be proceeded with at once. It is not expected that coal will be turned until about Easter, and it is hoped in twelve months' time to bring the output of the pit to 10,000 tons per week. Should this expectation be fulfilled, it will be the means of finding employment for between 1500 and 2000 men. More than a hundred unemployed miners from the Bishop Auckland district have already been imported by the company to work at this pit, and further batches of men from the Durham coalfield will follow.

Coal Resources Survey.

A Committee has been appointed, in pursuance of the policy of carrying out the physical and chemical

survey of the national coal resources, to deal with the coalfields of Nottinghamshire and Derbyshire. The composition of the Committee is as follows:—Mr. H. E. Mitton and Mr. C. W. Phillips, representing the Midland Counties Colliery Owners' Association; Mr. C. H. Heathcote, Notts. and Erewash Valley Colliery Owners' Association; Mr. J. W. Whitaker, Midland Counties Institution of Engineers; Professor W. H. McLillan; Mr. C. N. Bromehead, of the Geological Survey of Great Britain; Dr. C. H. Lander, *ex-officio*, Director of Fuel Research; and Mr. F. S. Sinnatt, *ex-officio*, Superintendent of the Physical and Chemical Survey of the National Coal Resources.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

ALTHOUGH there is less activity in the Cleveland pig iron trade, it is entirely due to producers having sold as extensively as they care to at present. Consumers are still anxious to buy forward at round about current prices, and as indicating the prevailing view of the trend of events, it may be mentioned that a fair parcel of iron for delivery over the second half of the year has been sold at a premium on present quotations. Makers still affirm that in spite of the fall in the price of coke there is no profit in pig iron production, and the only inducement to restarting more plant is that it tends to reduce costs by a wider distribution of standing charges. But there is a real shortage of iron, and to meet purely domestic needs some increase in the output has been found necessary. Dorman, Long and Co., Ltd., have put in another blast-furnace this week at their Newport Ironworks, but it is understood that there will be no addition to the amount of iron available for the open market, as the whole of the extra output is required for the firm's steel plant. This is the third blast-furnace to be lighted up this month, and increases the number in operation on the North-East Coast to 40. It is understood that Bolckow, Vaughan and Co., Ltd., are also contemplating putting another furnace into blast, and preparations are being made at other works to increase the output. There has been a much quieter feeling on the market this week, but there is not the slightest sign of weaker prices, sellers firmly maintaining their quotations at the following levels for home orders:—No. 1 Cleveland foundry iron, 72s. 6d.; No. 3 G.M.B., 70s.; No. 4 foundry, 69s; No. 4 forge, 68s. 6d.; and mottled and white iron, 68s. 6d. Export quotations in all cases are 6d. per ton above the foregoing.

Hematite Pig Iron.

Hematite makers are very busy, having orders on hand which will keep them fully employed at the present rate of output for many months. There is practically no iron available for early delivery. Prices are firm, mixed numbers being quoted at 78s., and No. 1 quality at 78s. 6d. per ton.

Ironmaking Materials.

A fortnight's imports of foreign ore into the Tees total no less than 113,409 tons, and works have such heavy stocks that they have no need to buy. Nevertheless quotations are maintained on the basis of 21s. 6d. per ton c.i.f. Tees for best Rubio ore. The coke market is weak and irregular. Sellers of Durham furnace coke generally quote 21s. per ton delivered at the works, but it can be bought at 20s.

Manufactured Iron and Steel.

Further improvement is reported in the manufactured iron and steel trade. There is quite a large volume of inquiry for semi-finished materials, but actual sales have not yet apparently been on an extensive scale. Orders for ships have been followed by some improvement in demand for heavy forgings, castings, plates, angles, and rivets. Purchasing of most kinds of finished steel is spasmodic, but manufacturers have a fair amount of work on hand. Further sales of galvanised sheets are understood to have been made to the Far East and India. Prices are unchanged.

The Coal Trade.

After an easy turn the Northern coal market has assumed a much steadier tone. Inquiries have fallen off to some extent, for, in addition to the ruling high prices of coal, freights have advanced, and this is weighing seriously in the minds of foreign buyers, who are hesitating to place further orders under present conditions. This has not affected the general position, however, as most of the collieries in Northumberland and Durham have good order books to the end of the month. While prices are steady it would take little new trade to recreate the firmness which was experienced at the end of January. Producers do not regard the present lull as other than of a transitory kind, and they regard it as extremely likely that the demand will return as soon as present orders are wiped off. Following the more settled weather conditions, tonnage has arrived at the berths in greater volume, and in some quarters there is a fear that the present rate of arrivals, if maintained, will create congestion. Meanwhile shipments are assuming a far larger scale. There are very limited supplies of Northumberland steam coals on offer for this month, and fitters are again quoting very steady prices, both for prompt and forward. For the most part buyers for next month's deliveries, however, are still inclined to hold off, although a fair number of orders have been placed. Best steam qualities are at a minimum of 16s. 6d., through second hands, but direct quotations still rule at 17s. There is a weaker feeling in the market for steam smalls, which, for the time being, attract a very quiet trade. Prices remain unchanged at 9s. for bests and 8s. 6d. for seconds. There is no special feature in the Durham markets, and prices everywhere continue at late levels. Gas coals are in quiet demand. Good classes are well taken up and steadily quoted at 18s., but secondary qualities are just holding to 16s. to 16s. 3d. Coking coals show an easier trend at 15s. 6d. to 16s., and offers of supplies are plentiful. There is no fresh development in the coke trade. Supplies available are more than ample for all needs, and prices are none too surely held. Gas makes for prompt are well accounted for, but forward prospects are irregular. The price remains at 23s. to 24s. Patent foundry classes are featureless and weakly held at 19s. to 21s., and beehive brands are nominal at 30s. to 32s.

SCOTLAND.

(From our own Correspondent.)

Motor Ship Contracts.

MOTOR ships bulk largely in the recent shipbuilding contracts, and the number is still being added to. William Beardmore and Co., Ltd., Dalmuir, have just received an order for three motor ships on behalf of a South American concern. These vessels will be high-class passenger and cargo vessels, 400ft. in length and 5000 tons each, and will be propelled by twin-screw Beardmore-Tosi internal combustion engines of the builders' make. These three vessels bring the number of motor ships ordered during the past two weeks up to twelve. It is hoped that rumours to the effect that the same firm has secured an order for one of the cruisers recently tendered for will turn out to be correct. If so, the outlook for the Clyde, which has improved a shade recently, will begin to assume a much brighter appearance.

Alexandria and Silk Industry.

The Dumbarton County Council at a recent meeting unanimously agreed to give the Textile Dyes and Development Company, Ltd., London, an option to purchase a portion of ground having a frontage on the river Leven. This company intends to utilise water from the Leven in connection with the silk-finishing process, for which the company secured an option on the purchase of the Argyll Works, Alexandria.

Pig Iron.

Most producers of pig iron in Scotland are carrying fairly heavy stocks, and all demands for material are readily met. The turnover is quiet and prices are barely steady.

Steel.

Makers of steel material in general are still greatly in need of fresh orders. Plates and sectional material are slow to move, and competition is such that prices are weakening. Quotations for ship plates and sections are approximately £7 10s. and £7 per ton respectively.

Steel Sheets.

The demand for black and galvanised sheets of the lighter variety shows no sign of weakening, and most makers are well off for orders. Prices are fully maintained. Heavy sheets are not so well off as light sheets, but continue to show some improvement. In fact, one or two makers report that they are now full up with orders for sheets of the heavier gauges.

Iron.

The demand for bar iron is merely maintained on recent levels. The re-rolled steel department of this industry is busier, but the prices obtainable are none too generous. Tube strips are in good demand at present.

Coal.

A change is noticeable in the export branch of the Scottish coal trade. Steamers have been slow to arrive, and foreign demands have been somewhat disappointing. Consequently, supplies of fuel have been forced on the market, and prices have weakened. Lanarkshire splints, first and third-class Fifeshire steams are well placed for orders, but almost all other sorts are weakening. Large fuel in Ayrshire and treble nuts in Fifeshire are the only other exceptions. Ayrshire fuels are in steady demand for the Irish market. Aggregate shipments amounted to 271,991 tons, against 264,898 tons in the preceding week, and 234,199 tons in the same week last year. Home demands for fuel are moderate.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE have been several interesting developments affecting both the steam and anthracite coal industry of this district since I wrote a week ago. While the conditions governing the steam coal section are not quite so firm for prompt loading owing to the fact that tonnage is not so plentiful, still the prospects of the immediate future are fairly good. Collieries are, as a matter of fact, well sold on paper, but merchants find it rather difficult to secure ready tonnage, and rates are still in an upward direction for outward business owing to homeward freights being exceedingly depressed. The inquiry ahead for steam coals is pretty well maintained, and it affords some satisfaction to find that following on the action of the Paris–Orleans Railway coming to this district again for supplies, the Paris, Lyons and Mediterranean Railway has purchased quite a considerable quantity of both large and small coals, chiefly the latter, and some patent fuel. The full quantity is not known, as the business has been placed in the hands of a number of exporters, but there is no doubt that it runs well over 100,000 tons to be delivered by the end of April. The P. L. M. Railway has not altogether suspended taking coals from South Wales during the past few months, like some of the other French Railways, but the quantity has certainly been substantially reduced. The Belgian Congo Railway is also in the market for about 15,000 to 20,000 tons of patent fuel for delivery over the next few months, while the Andalusian Railways have placed business for 20,000 tons of Admiralty large coals for shipment from March to the end of June, the firm credited with having secured this order being Messrs. A. J. Pope and Co., of Cardiff. The Portuguese have also contracted for 25,000 tons of large and small coal for shipment to Lisbon and Oporto over the next two months.

American Anthracite Strike Ends.

Just when the demand for tonnage to lift Welsh anthracite coals for shipment to America was beginning to get very pressing and rates of freight for prompt boats were reaching a quite abnormally high level, thus causing exceptional interest in the market, the news came at the end of last week that the strike of American anthracite miners had come to an end. The result was greater interest still, for this development was calculated to have an important bearing on all other freight markets and on the local anthracite market. As is usual on the termination of a coal strike in America, some of the buyers on the other side have made strenuous efforts to cancel cargoes of coal previously arranged, but there is no doubt that except in isolated cases they will be kept to their bargains and, therefore, although the strike in the American coalfield is at an end, there will still be considerable shipments from this country during the next few weeks, so that although the Welsh anthracite market may show a less firm appearance for a while, it will not be for long, as next month will see the commencement of shipments to Canada. It is authoritatively announced that already contracts have been entered into for the supply of over half a million tons of Welsh anthracite to the Dominion during the coming season, and there is every indication that the exports to Montreal and Quebec principally, will establish a record. The American anthracite strike had lasted practically six months, and has meant a loss of output there of probably close on 40,000,000 tons. South Wales has, of course, benefited considerably by the labour troubles of the Americans, as it is estimated that over half a million tons of Welsh anthracite coals have been sent to the American Northern Range of ports since last August.

Cambrian Collieries Dispute Settled.

After a stoppage covering eighteen months the dispute concerning the Cambrian Collieries has been settled, much to the relief of the workmen and their families in the neighbourhood. These collieries employed about 3500 men, of whom about 1300 have found work in other pits in the district. The precise terms of the settlement have not been divulged, but although opposed by some of the extremist section, the great majority of the men were surprised at the conditions and accepted them readily. The task of bringing about a settlement has been a very arduous one for the parties negotiating, as may be imagined from the fact that thirteen price lists had to be arranged. It is difficult to assess accurately what the strike has cost, but it is estimated that the stoppage has entailed a loss of output of over a million tons of coal and the workmen have forfeited approximately £860,000 in wages. In some quarters it is computed that the district has lost something over four millions through the stoppage. It is expected that about a thousand men will be able to find work almost immediately.

Contract for Sleepers.

Guest, Keen and Nettlefolds, Ltd., are reported to have secured a contract for the supply to the Egyptian State Railways of 100,000 steel sleepers.

Traffic Returns.

According to the returns issued by the Great Western Railway Company for the period from January 1st to 24th, the total exports from the Welsh ports under its control were 2,181,498 tons, a decrease of 72,953 tons, as compared with the same period of last year. Imports amounted to 342,956 tons, as against 370,346 tons. Coal and coke exports came to a total of 1,877,391 tons, compared with 1,942,032 tons for the corresponding period of last year, a reduction of 64,641 tons.

Current Business.

Operations on the steam coal market for current shipment have been on a fair scale but cannot be described as altogether active. According to the books of the collieries they are well sold, but unfortunately for them the tonnage which has been chartered has not come along to time in the case of a number of steamers, and merchants have found the supply of unchartered prompt steamers rather scarce. The result is that the market has not been quite so firm for coals for quick shipment, although nominally quotations have not undergone appreciable alteration, but there is no doubt that in individual cases colliery salesmen have been ready to shade their prices to those who could ship immediately. Sellers' ideas for delivery ahead, however, are firm, and many collieries will not, in fact, quote for next month. Pitwood values have advanced rapidly, and are practically nominal. The news came last week that there were labour troubles at Bordeaux, with the result that work has been suspended on the loading of all boats at that port with pitwood. The result was that by the end of the week prices had risen to 40s. to 45s. for prompt supplies. The majority of collieries do not keep large stocks of this commodity, and it is not improbable that work at some pits may be interfered with if supplies of pit timber run short. There is no sign so far of a settlement of the dispute.

THE use of the term "Uganda Railway" has always been incorrect. The railway in question leads to Uganda, but it is wholly in Kenya. Under an Order in Council, the office of High Commissioner of Transport for Kenya and Uganda has been instituted, and it has been officially decided that the railway is to be known as the Kenya and Uganda Railway.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	21/-
(1) Spanish	18/6
(1)N. African	18/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. Coast—		
Hematite Mixed Nos.	3 18 0	3 18 0
No. 1	3 18 6	3 18 6
Cleveland—		
No. 1	3 12 6	3 13 0
Silicious Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 7 6	3 8 0
White	3 7 6	3 8 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0	—
,, Forge	2 16 0	—
(3) Derbyshire—		
No. 3 Foundry	3 7 6	—
Forge	3 2 0 to 3 3 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast— N. Lancs. and Cum.— Hematite Mixed Nos.	4 10 0 (a); 4 12 6 (b); 4 17 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 10 0 to 11 15 0	
Second Quality Bars	10 15 0 to 11 0 0	
Hoops	15 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up.	7 10 0	—
Sections	7 0 0	—
Steel Sheets, under 3/16in. to ¼in.	9 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£17 to £18

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E Coast—		
Ship Plates	7 7 6	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light ,,	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
Manchester—		
Bars (Round)	8 5 0 to 8 15 0	
,, (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	6 15 0 to 7 0 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet Bars	6 2 6 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 0 0 to 16 5 0	
Angles	7 2 6 to 7 5 0	
Joists	7 2 6 to 7 5 0	
Toes	8 2 6 to 8 5 0	
Bridge and Tank Plates	7 15 0 to 8 0 0	
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/1½ to 19/7½
Block Tin (cash)	287 15 0
,, (three months)	280 10 0
Copper (cash)	59 17 6
,, (three months)	60 17 6
Spanish Lead (cash)	34 0 0
,, (three months)	34 0 0
Spelter (cash)	35 16 3
,, (three months)	35 16 3
Manchester—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	66 15 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	37 0 0
,, Foreign	36 0 0
Spelter	38 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 to 2/2 per lb.	
Ferro Tungsten	1/11 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£21 0 0	7/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£40 0 0	14/-
,, ,, 1 p.c. ,,	£46 0 0	15/6
,, ,, 0·70 p.c. carbon	£56 0 0	17/6
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	3/6 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0	scale 5/- per unit
,, ,, 75 p.c.	£21 0 0	scale 6/- per unit
,, Vanadium	14/- to 15/- per lb.	
,, Molybdenum	6/- per lb	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£172 to £175	
Cobalt	10/- per lb.	
Aluminium (per ton)	£120	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	17/-
,, ,, Ell	17/3
,, ,, Splint	19/6 to 22/6
,, ,, Trebles	16/3
,, ,, Doubles	15/9
,, ,, Singles	13/3
Ayrshire—	
(f.o.b. Ports)—Steam	16/6
,, ,, Jewel	17/-
,, ,, Trebles	17/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13,3 to 16/3
Screened Navigation	21/6
Trebles	18/- to 19/-
Doubles	15/6
Singles	13/3
Lothians—	
(f.o.b. Leith)—Best Steam	15/3
Secondary Steam	14/9
Trebles	16/9
Doubles	16/-
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	24/6
Household	40/- to 48/-
Coke	27/-
Northumberland—	
Best Steams	16/6 to 17/-
Second Steams	15/6 to 16/-
Steam Smalls	9/-
Unscreened	14/-
Household	20/- to 22/-
Durham—	
Best Gas	18/-
Second	16/- to 16/3
Household	20,- to 22/-
Foundry Coke	19/- to 21/-

Sheffield—	Inland.	
Best Hand-picked Branch	31/ to 34/-	
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire ,,	16/- to 19/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o b.	19/- to 20/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	23/- to 24/-
Second ,, ,,	21/6 to 22/6
Best Dry Large	21/- to 22/-
Ordinary Dry Large	20/- to 20/6
Best Black Vein Large	21/- to 21/6
Western Valley Large	20/- to 21/-
Best Eastern Valley Large	20/- to 20/6
Ordinary ,, ,,	19/- to 20/-
Best Steam Smalls	13/- to 13/6
Ordinary ,,	11/- to 13/-
Washed Nuts	19/- to 29/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	16/- to 17/-
No. 2 ,, Large	19/6 to 20/6
,, ,, Through	16/- to 17/-
,, ,, Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/- to 22/6
Pitwood (ex ship)	40/- to 42/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	40/- to 42/6
Seconds	33/- to 35/-
Red Vein	27/- to 30/-
Machine-made Cobbles	52/6 to 55/-
Nuts	55/- to 57/6
Beans	42/6 to 45/-
Peas	21/- to 24/-
Breaker Duff	7/- to 8/-
Rubbly Culm	9/- to 9/6
Steam Coals:	
Large	22/- to 23/6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/- to 17/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

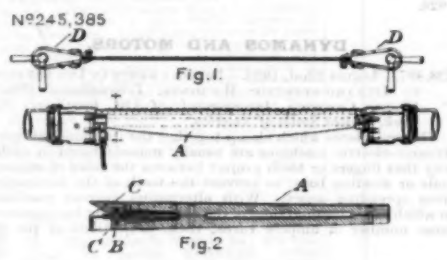
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

installation in the event of defects arising in the windings or in the insulation. In order to prevent such danger, appliances of this kind are connected to the source of current through safety fuses. Up to the present, it has not, the inventors contend, been found possible to construct high-tension safety fuses capable of protecting the device against currents due to defects, or fuses which cut off properly in the event of short-circuiting. In most instances the energy developed in cutting off causes the safety device to explode. The object of this invention is to overcome these defects. In the drawing A denotes a current-consuming apparatus, for example, a measuring transformer, B a limiting resistance, C a release pawl of a circuit breaker, and D a movable contact of the circuit breaker provided with a hook E and a tension spring F. This device operates in the following manner: —Under normal conditions the current passing through the consuming device A, resistance B, and contact D heats the resistance B and causes it to expand. The latter is, however, so adjusted that this expansion will be insufficient to actuate the release C. When a defect occurs in the measuring transformer A the heating effect is increased, which causes the resistance B to expand to such an extent as to displace the pawl C and thus release the hook E. The tension spring F, which then comes into action, draws back the contact D and thus automatically disconnects the defective apparatus from the line circuit. The limiting resistance B may be of small dimensions, and must be designed for only temporary loads, since the smaller its volume the more rapidly does it become heated and the sooner is the device to be protected cut off.—*January 14th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

245,385. September 14th, 1925.—TREE-FELLING SAWS, A. G. de Northall, 619, East Washington-street, Indianapolis, U.S.A.

It appears from the specification that the inventor has made and tried this rather remarkable saw, the working part of which is composed of a number of short toothed sections that butt against one another and are pushed along guiding grooves by air motors. The guide A, of which a section is given in Fig. 2, is hollow to provide an air connection between the two motors at

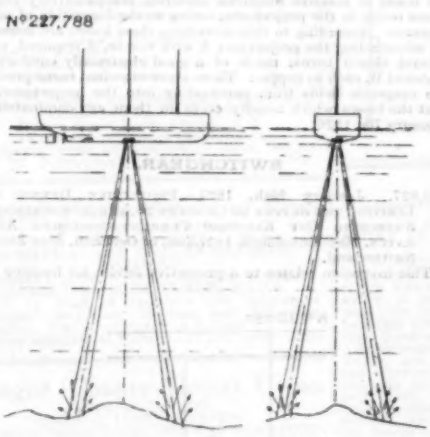


opposite ends of the saw. Towards the cutting edge there is fixed the cruciform piece B, and between this piece and the guide member there are inserted the toothed sections C C. At either end of the apparatus there is a housing D D, with a looped passage, so that the sections may travel up one side of the guide and down the other continuously. There is a sprocket at either end, connected with the air motors, for pushing the saw sections along, and the exhaust air is used to blow away the sawdust and cool the working parts.—*January 7th*, 1926.

SHIPS AND BOATS.

227,788. September 1st, 1924.—MEASUREMENT OF SPEED, C. Chilowski, 15, Rue de Lunain, Paris.

The inventor proposes to determine the speed of ships by means of ultra-audible waves sent out from the ship and reflected back again by the bottom of the sea. He produces two pairs of beams of waves, set at an angle to one another, as



shown in the illustration, one pair for fore and aft movement and the other for leeway. Apparatus is provided for receiving the reflected waves, and the difference in note between the two reflected beams is a measure of the speed of the vessel. The specification describes the necessary apparatus.—*January 1st*, 1926.

WELDING.

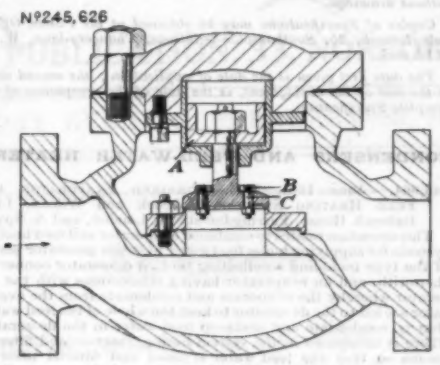
230,831. March 11th, 1925.—IMPROVEMENTS IN OR RELATING TO THE COATING OF WELDING ELECTRODES, Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Berlin-Siemensstadt, Germany.

This invention relates to a process for making the sheathing of welding electrodes. The coatings consist of paper or paper pulp in which additions are introduced during manufacture. Part or all of the requisite additions in a finely distributed condition can be added to the liquid pulp during the manufacture of the paper from which the sheath is subsequently made, so that a paper is obtained that possesses all the properties necessary for welding. If desired, the paper pulp can be pressed round the welding iron. The advantage of the new process lies more particularly in the fact that the additions are present everywhere in the substance of the sheath in uniform thickness, of uniform composition and in a finely distributed condition, so that, it is claimed, absolute uniformity and good welding are secured.—*January 14th*, 1926.

MISCELLANEOUS.

245,626. February 19th, 1925.—ISOLATING VALVES, Cockburns, Ltd., and D. MacNicoll, Clydesdale Engineering Works, Cardonald, near Glasgow.

This isolating valve is said to be especially suitable for service in connection with boilers working at high pressures—say,



800 lb. per square inch. As will be seen from the illustration, it is equipped with a dashpot A and a breathing plate B, the movement of which is limited by the studs C. Both dashpot and breathing plate are on the outlet side of the valve.—*January 14th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

DIESEL ENGINE USERS' ASSOCIATION.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Heavy Oil Engine Installations: Choice of Site and Lay-out of Plant," by Mr. Geoffrey Porter. 3.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Coventry. Coventry Graduates' annual dinner. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Annual dinner. 6.30 for 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Annual general meeting. Paper, "The Measurement of Cutting Temperatures," by Mr. E. G. Herbert. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Council House, Birmingham. West Midland District meeting. Paper, "Concrete in Modern Road Construction," by Mr. H. V. Overfield. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Coal-cutting Machinery," by Mr. S. Reilly. 7.30 p.m.

RAILWAY CLUB.—65, Belgrave-road, London, S.W. 1. Annual general meeting, followed by presidential address. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "George III. in his Papers," by Hon. J. W. Fortescue.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Lecture, "The Development of Electricity," by Professor W. Cramp. 7.30 p.m.

SATURDAY, FEBRUARY 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Florence Restaurant, Rupert-street, London, W. 1. London Graduates' annual dinner and dance. 6.45 p.m.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Dudley Arms Hotel, Dudley. Annual dinner. 6 p.m.

MONDAY, FEBRUARY 22ND.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. Lecture, "Recent Improvements in Measuring Apparatus as Used by Mechanical Engineers," by Mr. T. H. Armstrong. 7.30 p.m.

FARADAY SOCIETY.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers: "The Influence of Alternating Currents on the Electrolytic Corrosion of Iron," by Messrs. A. J. Allmand and R. H. D. Barklie; "The Direct Oxidation of Manganous Ion to Permanganate," by Dr. A. N. Campbell; "The Elasticity of Jellies of Cellulose Acetate in Relation to their Physical Structure and Chemical Equilibria," by Mr. H. J. Poole; "Adsorption, II.: The Adsorption by a Coconut Charcoal of Saturated Vapours of some Pure Liquids," and "Adsorption, III.: Stages in the Adsorption by a Coconut Charcoal from the Saturated Vapour over Liquid Mixtures of Alcohol and Benzene and of Acetone and Benzene," by Messrs. F. G. Tryhorn and W. F. Wyatt; "A Device for Circulating Fluids under High Pressure," by Mr. I. R. McHaffie. 5.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Pistons," by Mr. S. Robertson. 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—Chamber of Commerce, Birmingham. Paper, "Arterial Road Construction," by Mr. H. F. Lea. 7.30 p.m.

RAILWAY CLUB.—65, Belgrave-road, London, S.W. 1. Paper, "Development of the Railway Carriage," by Mr. B. M. Bazley. 8.15 p.m.

TUESDAY, FEBRUARY 23RD.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. "The Principles and Practice of Automatic Steering," by Mr. F. S. Clifford. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Paper, "American Automobile Design," by Mr. L. H. Pomeroy. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Papers: "The Khyber Railway," by Mr. Victor Bayley; and "The Survey and Construction of the Khyber Railway," by Colonel G. R. Hearn. 6 p.m.

WEDNESDAY, FEBRUARY 24TH.

ELECTRICAL POWER ENGINEERS' ASSOCIATION: MIDLAND DIVISION.—Grand Hotel, Birmingham. Lecture, "Protective Gear," by Mr. G. L. Porter. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Milton Hall, 244, Deansgate, Manchester. Paper, "Sleeve Valve Engine Development," by Mr. W. Ferrier Brown. 7.15 p.m.

NEWCOMEN SOCIETY.—Science Museum, South Kensington, London, S.W. 7. Paper, "Matthew Murray—A Centenary Appreciation," by Mr. G. F. Tyas. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Domestic Heating," by Dr. Margaret Fishenden. 8 p.m.

ROYAL MICROSCOPICAL SOCIETY.—20, Hanover-square, London, W. 1. Paper, "The Application of the Microscope to the Examination of Pigments and Paints," by Mr. C. A. Klein. 7.30 p.m.

THURSDAY, FEBRUARY 25TH.

ENGINEERING GOLFING SOCIETY.—Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual general meeting. 12 noon.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Training School of Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "The Straight Eight Engine," by Mr. E. W. Sisman. 7.30 p.m.

INSTITUTION OF MINING AND METALLURGY.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers: "An Occurrence of Zinc Silicate Ore of Supposed Primary Origin," by Mr. S. J. Speak; "Liquidation in Molten Alloys and its Possible Geological Significance," by Mr. S. W. Smith. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Lecture, "The Atom of Light and the Atom of Electricity," by Dr. C. D. Ellis. 5.15 p.m.

FRIDAY, FEBRUARY 26TH.

CHADWICK PUBLIC LECTURE.—Institution of Civil Engineers' Great George-street, London, S.W. 1. "The Activated Sludge Process of Sewage Treatment," by Dr. H. T. Calvert. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Signalling from a Driver's Point of View," by Mr. W. J. Thorrowgood. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "Locomotive Built-up Cranks," by Mr. G. N. Shawcross. 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Society of Motor Manufacturers, 83, Pall Mall, London, S.W. 1. Debate on "Payment by Results." 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecture, "Seven Thousand Years of Shipping," by Mr. J. F. Petree. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. Paper, "Hydro-mechanical Gearing," by Mr. James Richardson. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Nicolas de Peiresc and his Circle," by Dr. C. Hagberg Wright. 9 p.m.

UNIVERSITY COLLEGE ENGINEERING SOCIETY.—The Refectory, University College, Gower-street, London, W.C. 1. Annual Dinner.

SATURDAY, FEBRUARY 27TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Northolt Wireless Station.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council House, Bishops Stortford, Herts. Eastern District meeting. 2.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Bridport. South-Western District meeting. 2 p.m.

MONDAY, MARCH 1ST.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "State Ownership of Waterways," by Mr. H. D. Dickinson. 5.30 p.m.

TUESDAY, MARCH 2ND.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. Paper, "Electrical Deck Machinery," by Mr. J. Mansel Lewis. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Some Problems we Meet," by Mr. L. H. Dawtrey. 7.15 p.m.

WEDNESDAY, MARCH 3RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Cavendish Café, Cornmarket, Derby. Derby Graduates' meeting. Paper, "Permanent Mouldings and Die Castings," by Mr. L. A. Selvey. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "Road Construction," introduced by Mr. H. E. Lightfoot. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Science in the Cable Industry," by Mr. P. Dunsheath. 8 p.m.

FRIDAY, MARCH 5TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Tendencies in Modern Electric Practice," by Mr. J. M. Seddon. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Hoisting Appliances," by Mr. C. H. Woodfield. 7.30 p.m.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has obtained a six months' contract for the supply of Mazda vacuum and gas-filled lamps to the Southern Railway.

NOTWITHSTANDING the fact that power from a hydro-electric supply is available, the directors of the La Guaira and Caracas Railway Company, Ltd., have, on the advice of their consulting engineers, decided to install a Diesel engine power station, and have placed an order with Mirrlees, Bickerton and Day, Ltd., Stockport, for three 750 brake horse-power Diesel engines to drive dynamos for the electrification of their line.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Ferry Boats.

In view of the remarkable work accomplished during the war by the train ferry boats running between Richborough and Dunkirk there appeared to be some prospect of that service being maintained and even extended, but after the Armistice the Dunkirk Chamber of Commerce was not at all disposed to participate in the expense of continuing the service with an English port, and the idea of employing ferry boats appeared to be definitely abandoned. The question, however, was again revived about eighteen months ago, when the Ministry of Public Works consulted the railway companies upon the desirability of re-establishing the service, but in no case did the proposal meet with approval, probably because the Harwich-Zeebrugge service was at the time giving only moderate results. Since then the ferry boats between England and Belgium have developed the traffic so considerably that the French railway companies are beginning to fear that their interests may be jeopardised by the loss of traffic in transit, especially from Italy, which is now sending all its perishable produce through Zeebrugge. In that respect the value of the ferry boat is unquestioned. The Ministry of Public Works has therefore again canvassed the opinions of the railway companies and of the Chambers of Commerce of Dunkirk and Calais, and although no definite replies have yet been received, it would nevertheless seem that the advantages of the ferry boat are becoming recognised. The Chamber of Commerce of Dunkirk, for example, while not disposed to finance a service on the ground that ferry boats are more suitable for perishable goods which do not pass through that port, would favour the running of such boats by a private company, and there is reason to believe that a serious effort will be made to establish a service between Calais and Dover, especially for the convenience of travellers between London and Basle. The matter has, at any rate, entered upon a phase of practical investigation. If ferry boats are operating satisfactorily in the North Sea and in the Baltic, it is due largely to the small difference between high and low tides. In the Channel the amplitude is much greater, and it is urged that that fact presents difficulties which will have to be overcome if ferry boats are to be a success.

Floating Docks.

The last few years have seen remarkable improvements in the equipment of French ports, which are now provided with all that is necessary for dealing rapidly and economically with coal, oil and grain, and a particularly interesting departure is the importance attached to floating docks. As there were no floating dock specialists in this country little attention was paid until recently to such equipments, but the Chambers of Commerce of various ports have acquired floating docks which are found capable of rendering such valuable service that some docks of considerable dimensions have been ordered abroad. At Rouen a floating dock for ships of 2200 tons is now being equipped and will be ready for service in about a year. It is now proposed to purchase another capable of docking ships of 8000 tons. At Nantes there is a floating dock supplied by Germany on account of reparations, and for Bordeaux the Vulkan Shipyard, of Hamburg, is constructing a floating dock 220 m. long and 34 m. wide between the caissons. It will take ships of 25,000 tons.

Shipbuilding.

The efforts being made to revive the shipbuildng industry by means of subsidies are likely to remain ineffectual until the country's finances are put into something like order, for it is estimated that the total amount of grants yearly would be about 40 million francs, which could not be voted unless they were covered by revenue. As matters now stand a proposal, approved of by an extra-Parliamentary Commission, for granting subsidies to shipbuilders for a period of twelve years has been in abeyance for several months. The proposed subsidy would be equal to the difference between the French cost price and the British selling price, the latter being determined quarterly by a technical commission. The subsidy would serve little purpose unless it operated concurrently with the Crédit Maritime, which is also waiting to be introduced into Parliament. The Crédit Maritime aims at providing shipowners with the necessary credits to purchase ships from French builders, and it is proposed to raise the money for this purpose by levying a tax on all passengers landing and embarking at French ports. This project, however, raises international complications that are likely to render it inoperative, and some other means will probably have to be found of providing the required funds. Until the Crédit Maritime can be organised on an acceptable basis there is little hope of anything being done to subsidise the shipbuilding industry.

Coal Production.

The total production of the French collieries during 1925 amounted to 48,033,564 tons, an increase on the previous year of more than three million tons and an augmentation of about eight million tons as compared with the pre-war output of 1913. This result is eloquent of the higher efficiency of the modern equipment of the reconstructed collieries, and much can also be attributed to the encouragement offered to increased production by the lower value of the franc, as well as by the importation of foreign labour, which has permitted of a larger production, although with a smaller individual output. Nearly three-fourths of the total was produced by the collieries in the Nord and the Pas de Calais. The coal imports during 1925 amounted to 18,396,417 tons, of which Great Britain supplied 10,036,764 tons, Germany 5,517,944 tons, and Belgium 1,897,713 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

245,664. June 16th, 1925.—COMBINED EVAPORATOR AND FEED HEATING SYSTEMS, Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, and A. Spyer.

This invention relates to combined evaporator and feed heating systems for supplying boiler feed water in steam generator plants of the type including a collecting tank, a de-aerator connected therewith, and an evaporator having connections with the de-aerator whereby the evaporate and condensate from the evaporator are led to the de-aerator to heat the whole of the feed water, that is, condensate and make-up feed water in the de-aerator. There is interposed in the system liming, reaction and filtering means so that the feed water is limed and filtered prior to de-aeration. In the accopmanying drawing A denotes a collecting tank which receives feed water from the condensate and/or other sources of supply, B denotes the liming tank and C the

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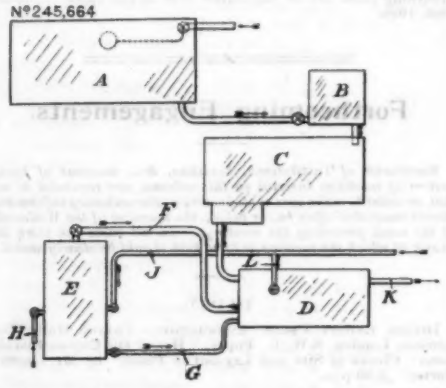

reaction and filtering tank. D denotes the de-aerator and E denotes the evaporator. As indicated by the connections and arrows, water supplied to the collecting tank A is led through the liming apparatus B and the reaction and filter tank C to the de-aerator D. Vapour or steam from the evaporator E is supplied through the pipe F to the heating elements of the de-aerator D. The evaporator coil drain G has a connection with the de-aerator by way of which hot drain water from the evaporator passes to the de-aerator. The water supplied by the pipe H to the evaporator is evaporated by direct steam supplied through the pipe J to the evaporator coils. K indicates the pipe by which the treated water is taken from the de-aerator to the pumps for supply to the boiler. Direct steam may be supplied at will to the heating elements of the de-aerator by way of the branch L from the pipe J.—*January 14th*, 1926.

INTERNAL COMBUSTION ENGINES.

245,685. August 13th, 1925.—STARTING HEAVY OIL ENGINES, Sir K. I. Crossley and W. le Plastrier Webb, Openshaw, Manchester.

The inventors propose to start the engine by means of a lighted wad A of paper treated with potassium nitrate. This wad is

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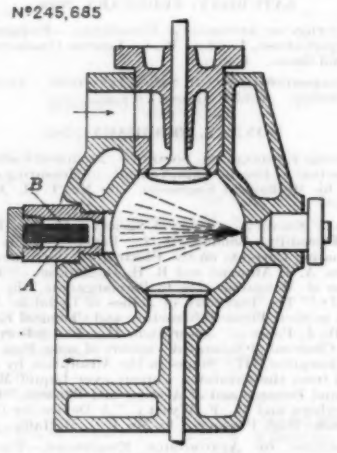

fixed in a holder B, the chief peculiarity of which is that it does not project into the combustion chamber and consequently has a long life. The holder is normally kept cool by radiation from its exposed surface, but can be used as an ignition tube, with the help of a blow lamp, in the event of no wad being available.—*January 14th*, 1926.

TURBINE MACHINERY.

245,583. December 24th, 1924.—HIGH-SPEED WATER TURBINES FOR LOW HEADS, Boving and Co., Ltd., and H. D. Cook, 50, Kingsway, London, W.C. 2.

This turbine is intended for working with varying heads, as, for instance, in connection with tidal basins. It is desirable to maintain the efficiency at full load, but not so much so at lesser loads. The blades of the runner are pivoted in the boss, so that their angle can be varied. The angle is controlled by the cam A and a connection running down the centre of the shaft, which is operated by the two floats B B and bell-crank C. The arrangement is such that the blades are always set at the angle to give

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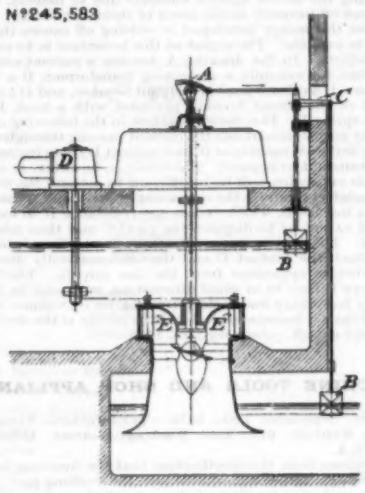

the best efficiency regardless of the head. A governor and servomotor D are used for controlling the angle of the guide vanes E in accordance with the load on the machine.—*January 14th*, 1926.

DYNAMOS AND MOTORS.

238,897. August 22nd, 1925.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, United States of America.*

The end plates which clamp together the iron laminations of dynamo-electric machines are usually manufactured in such a way that fingers or teeth project between the sides of adjacent coils or winding bars, to prevent the teeth of the laminations from spreading apart. With alternating current machines, in which the individual sides of the coil or winding bars possess a large number of ampère turns, these projections of the end

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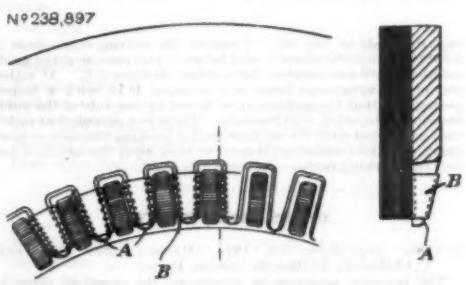

plates get very hot, as they are subject to a perpetual magnetic reversal, owing to the strong magnetic fields which the ampère turns of the bars or sides of the coil produce. As the end plates are made of massive magnetic material, comparatively heavy losses occur in the projections, owing to the formation of eddy currents. According to this invention, these losses are lessened by surrounding the projections A with one or, if required, with several closed turns, made of a good electrically conducting material B, such as copper. These short-circuited turns prevent the magnetic fields from penetrating into the projections, so that the losses which usually occur in them are eliminated.—*January 7th*, 1926.

SWITCHGEAR.

230,027. January 29th, 1925.—PROTECTIVE DEVICE FOR LIMITING THE SUPPLY OF CURRENT TO, AND AUTOMATICALLY SWITCHING OFF ELECTRIC CURRENT-CONSUMING APPARATUS, Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland.

This invention relates to a protective device for limiting the

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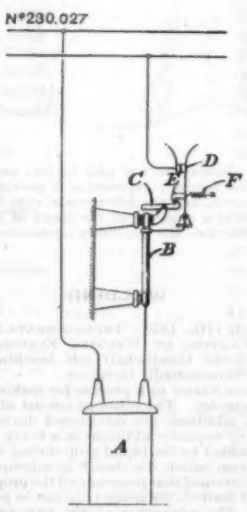

supply of current to and automatically switching off electric current-consuming apparatus. Voltage transformers and similar devices having a low consumption of current, especially those in high-tension installations, constitute a danger to the